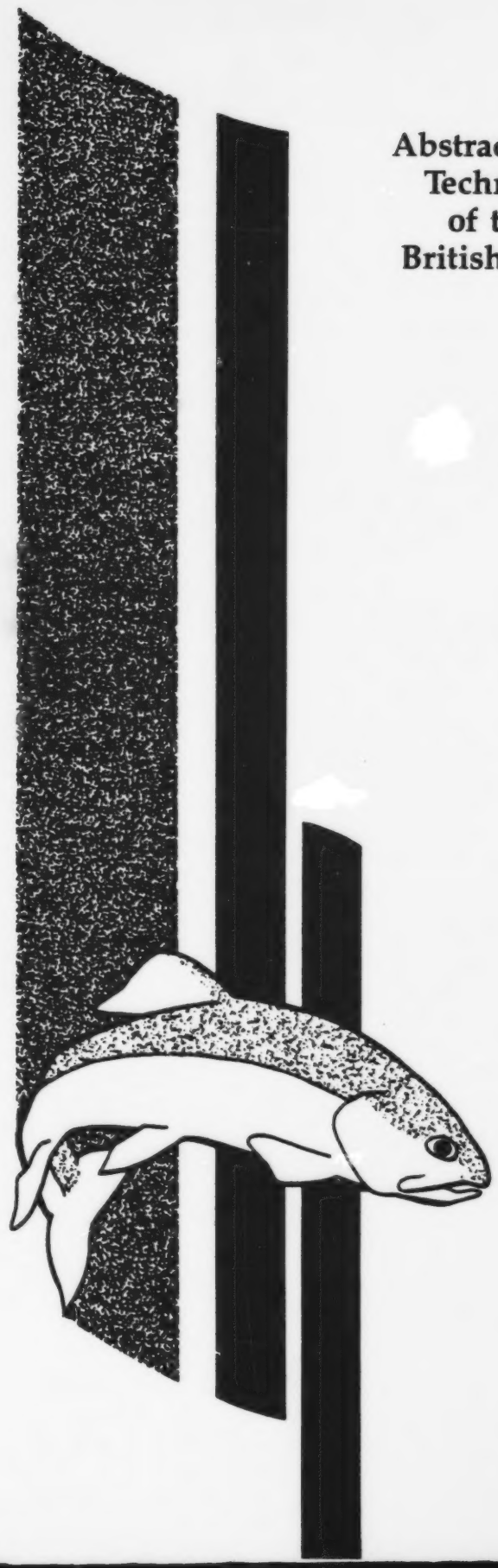

Abstracts of Fisheries Management Reports, Technical Circulars, and Project Reports of the Recreational Fisheries Branch, British Columbia Ministry of Environment 1985-88

by

JOEL O. SAWADA
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FISHERIES TECHNICAL CIRCULAR No. 86

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Province of British Columbia
Ministry of Environment

Fisheries Technical Circulars frequently contain preliminary data, and conclusions based on these may be subject to change. Reports may be cited in publications but their manuscript status (M.S.) should be noted.

ABSTRACTS OF FISHERIES MANAGEMENT REPORTS, TECHNICAL CIRCULARS, AND PROJECT REPORTS OF THE RECREATIONAL FISHERIES BRANCH, BRITISH COLUMBIA MINISTRY OF ENVIRONMENT 1985-88

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ABSTRACT

Sawada, J.O. 1989. Abstracts of Fisheries Management Reports, Technical Circulars, and Project Reports of the Recreational Fisheries Branch, British Columbia Ministry of Environment 1985-88, 55 p.

This publication is a compilation of 9 Fisheries Management Reports, 18 Fisheries Technical Circulars, and 96 Fisheries Projects of the Recreational Fisheries Branch of the British Columbia Ministry of Environment. Only reports dated 1985 through 1988 were included. Where abstracts were unavailable summaries, introductions or titles were used. The compilation was assembled from the files of the Research and Development Section of the Recreational Fisheries Branch, and may be incomplete. To aid in future publications of this kind, please ensure that a standard abstract is included in all reports.

FISHERIES MANAGEMENT REPORTS

Hooton, R.S. 1985. A Questionnaire Survey of Vancouver Island Steelhead Anglers' Opinions and Preferences on Management Issues in 1976/77. Fisheries Management Report No. 84, 30 p.

A questionnaire, which was mailed to a systematic sample of every second Vancouver Island steelhead trout angler, was used to evaluate their preferences for fishery management policies. The main objective was to assess angler attitudes toward augmenting steelhead production by stocking hatchery fish, and to develop recommendations for incorporation into a steelhead management plan for Vancouver Island.

A total of 1,693 completed forms out of 3068 (62%) were returned. Most Vancouver Island steelhead anglers had fished for five years or less, fished only during winter months, and failed to catch a steelhead. Years fished, days fished, and catch were highly variable and not correlated. A small proportion of anglers accounted for a large proportion of the steelhead catch. Lists of favorite streams, most fished streams, and streams most preferred for stocking were similar. Anglers belonging to a fishing club or society comprised 17% of the sample and some significant differences were apparent in the behavior, experiences, and management preferences of club versus non-club anglers. Sixty-one percent of all respondents favored production of steelhead from hatcheries for Vancouver Island in general and 85% favored hatchery production for the Campbell/Quinsam river system. The results emphasized the need for the Fisheries Branch to acquaint anglers with all aspects of the hatchery steelhead issue and to publicize the intent of catch and release regulations. Postal contact was the recommended option for reaching anglers. In view of the diversity of respondent experiences and preferences, it was recommended that management units contain fishing options roughly in proportion to user group preferences.

The potential bias associated with estimates of steelhead harvest based on a single mail out survey was also described; the need for accurate estimates identified; and an alternate approach involving follow-up contact and regression procedures suggested. Considering the highly unequal distribution of steelhead catch amongst anglers, it was recommended that experimental regulations limiting the number of steelhead an angler could release be instituted on at least one stream.

Hooton, R.S. and V.A. Lewynsky. 1985. Big Qualicum River Steelhead Fishery Investigations, 1976 to 1981. Fisheries Management Report No. 85. 28 p.

The Big Qualicum River steelhead fishery was surveyed from 1976-77 to 1980-81 to monitor angler use and success, and to assess the status of wild and hatchery steelhead stocks. Using a voluntary questionnaire with intermittent reinforcement by MOE personnel, angler effort, catch and catch

rates peaked in 1977-78 but declined each year thereafter. This was partically explained by the change to catch-and-release regulations for wild steelhead, but estimated stock sizes also showed a similar trend. Redd counts peaked in 1977-78, but also declined during each of the three subsequent years. Exploitation of hatchery steelhead averaged an estimated 45%. Similar exploitation of wild steelhead dropped abruptly after the change to catch-and-release regulations.

A cursory examination of hatchery steelhead survival found no apparent relationship between smolt-to-adult survival and the mean size of released smolts. However, data were too incomplete to be conclusive.

Hooton, R.S. and M.G. Lirette. Telemetric Studies of Winter Steelhead, Gold River, 1982-83. 1986. Fisheries Management Report No. 86. 18 p.

Studies of the freshwater ethology of wild winter steelhead trout (Salmo gairdneri) were conducted by the Ministry of Environment during the 1982-83 season on Gold River, a major steelhead river in northwestern Vancouver Island. Radio telemetry was employed to monitor in-stream movements and to determine the timing and location of spawning. From December 1982 to April 1983, 219 steelhead were angled a short distance upstream from tidal water; of these, 32 recent immigrants (14.6%) were tagged with internal radio transmitters, and movements monitored approximately weekly. Twenty-four of 32 radio tagged steelhead (75%) were tracked through spawning and emigration. Eight radio tags either malfunctioned, were lost to predation, or were regurgitated.

Of 219 tagged steelhead, 27 (12.3%) were reported recaptured by anglers. Recaptures were highest among steelhead tagged in December and January. Few February tags, and no March-April tags were recovered. Anchor tagged steelhead controls were recaptured nearly three times more frequently than radio tagged fish. Reduced catchability resulting from orally inserted transmitters with external antennae is implied. Telemetric observations also suggested that fish behavior may have been modified in the short term by internal transmitters.

Telemetric monitoring showed that early steelhead immigrants (December, January) occupied heavily fished areas of Gold River for three to four months prior to spawning, and recapture data confirmed the vulnerability of these fish to angling.

The relationship, if any, between stream temperature and discharge and the rate of upstream migration of tagged fish was not determined. However, substantial upstream movements were observed during periods of low and declining discharge. Steelhead spawning was randomly distributed throughout approximately 30 km of the mainstem. December and January immigrants spawned three to seven weeks earlier than February through April immigrants. Post-spawning emigration was rapid among both sexes.

Implications of study results to management of wild winter steelhead on Vancouver Island are discussed.

Parkinson, E.A. 1986. An Evaluation of the Relative Survival and Growth of Hatchery Kokanee Released at Different Sizes and Times in Skaha Lake, British Columbia. B.C. Fisheries Management Report No. 87, 17 p.

Size of release ranging from 1.4 to 5.5 g was not a significant factor in determining the subsequent survival of hatchery kokanee fry released into Skaha Lake. There was some indication that groups released later in the May 1 to July 30 period survived better but the relationship was weak (r^2 = .108). The lack of a relationship between survival and both size and time implies that other factors are important in determining post release survival. Although hatchery fish start out up to 18 times the size of wild 0+ fry in the spring of their first year, hatchery fish lose this size advantage and are essentially the same size as wild fish of the same age by their third summer.

Tsumura, K., J.M.B. Hume, and B.M. Chan. 1987. Effects of Size at Release in Rainbow Trout (Salmo gairdneri) Stocked in a Winterkill Lake. Fisheries Management Report No. 88, 15 p.

Growth and maturation rates were compared in three graded groups of hatchery reared, Pennask Lake, yearling rainbow trout (Salmo gairdneri) (wild stock origin) stocked in a productive winterkill lake. The groups were downgrades, upgrades, and large upgrades. Mean lengths of the downgrades, upgrades, and large upgrade groups at stocking were 81, 93, and 109 mm, respectively.

Incidence of early sexual maturity in age 1+ males was 31%, 43%, and 51% for all the fish in each of the downgrade, upgrade, and large upgrade groups, respectively. In comparisons of two catchable length and weight categories ($\geq$ 255 mm or $\geq$ 225 g; $\geq$ 280 mm or $\geq$ 340 g), there were 50% more precocious males in the large upgrades than either of the other grades in all categories. Percent of males which were precocious in the sub-catchable size category was 13, 13, and 1.4 for all the fish in each of the downgrade, upgrade, and large upgrade groups, respectively.

In the large upgrades, 92% of the fish were $\geq$ 225 g and 55% were $\geq$ 340 g, when sampled 5.7 months after stocking into a winterkill lake. The downgrades and upgrades consisted of 47% and 65% respectively, of fish $\geq$ 225 g, and 14% and 31%, respectively, of fish $\geq$ 340 g for the same growth period.

Stocking of large, graded fish into productive winterkill lakes is suggested as a technique to initiate a rainbow trout sports fishery in these lakes, and to reduce the numbers of precocious males in regularly stocked (non-winterkill) lakes.

Slaney, P.A. An Assessment of the Rainbow Trout Population (Salmo gairdneri in the Upper Nechako River and the Effects of a Sportfishery Closure. 1986. Fisheries Management Report No. 89. 37 p.

Rainbow trout inhabiting the Upper Nechako River were studied to document the population size, to determine the effectiveness of a sportfishery closure, and to evaluate the survival of stocked juvenile trout. Population enumeration and sampling was conducted at an upper "index reach" from 1983 (pre-closure) to 1986 (post-closure). Numbers and standing crop of catchable wild trout (> 20 cm) increased, two and 3.2 fold respectively. Corresponding increases in mean size of trout, age, and spawning frequency also occurred. Mean weight increased 64%, and 18% of the trout were > 0.5 kg by 1985 in contrast to 0% > 0.45 kg prior to the closure. Standing crop of wild trout in the index reach in 1986 approached earlier predictions of carrying capacity (Slaney et al. (1984 MS). At other study sites, examined less intensively, trout were less abundant although size and age structure were similar.

Survival of stocked juvenile trout (Premier Lake strain) was exceptionally low (1 - 2%) within the 10 km stocking site; fish apparently moved throughout the river. Preliminary results from stocking of stream strain (Blackwater River) in the "index reach" suggested higher survival, restricted movement, and comparable growth to wild trout in the river, although further assessment is required in 1987.

Fisheries management implications are that the population has recovered rapidly from over-exploitation; restoration should continue provided (1) appropriate special and restrictive regulations are invoked when the sport fishery is re-opened, (2) an adequate flow regime is maintained, as recommended by Slaney et al. (1984), and (3) restorative measures are initiated in tributaries to increase spawning and juvenile rearing areas. Further fish enhancement measures are also recommended to maximize sport fishery opportunities in this previously underrated recreational river.

Johnston, N.T., C.J. Perrin, H.A. Andrusak, and E.A. Parkinson. 1988. The Early Growth of Kokanee (Oncorhynchus nerka) Fry in Relation to Ration. Fisheries Management Report No. 90, 13 p.

The growth rates of newly-emerged kokanee fry reared at ambient conditions of temperature and food in net pens in the West Arm of Kootenay Lake were 3.5 to 4.9% per day during two 20-day experiments. Kokanee fry reared under the same regime of temperature at a series of fixed rations (4 to 32% body weight.d^{-1}) at the Meadow Creek hatchery had maximum daily growth rates of 2.4% at excess rations. The growth of hatchery-reared fry generally increased with increasing rations. except that fry did not gain weight at the 4% ration. The early growth of kokanee fry in the West Arm did not appear to be adversely affected by recent decreases in nutrient loadings to the lake.

Stone, Michael. Economic Values and Impacts of Freshwater Sport Fishing in British Columbia. 1988. Fisheries Management Report No. 91. 61 p.

British Columbia freshwater results of the 1985 National Survey of Sport Fishing in Canada were used to determine angler expenditures, economic impacts of these expenditures on the B.C. economy, and the net economic values that British Columbians derived from the freshwater sport fishery during 1985.

It is estimated that anglers spent a total of $303.5 million in pursuit of their sport in British Columbia during 1985. Of this total $144.1 million was spent on direct angling expenditures and $159.4 million on capital equipment purchases attributable to sport fishing. Of the $303.5 million total 86% was spent by residents of British Columbia and 14% by non-residents.

Economic impacts were estimated using the angler expenditure data and the British Columbia Input-Output Model. It is estimated that angler expenditures during 1985 supported 5,238 person years of employment, $110.5 million of household income and $174 million of provincial gross domestic product. In addition, it is estimated that $32 million of provincial government tax revenue was generated.

The value of British Columbia's freshwater sport fishery was calculated using the people of British Columbia as the referent group. This means that different methods had to be used to determine the value British Columbians derived from resident and nonresident angling. The value of resident angling was determined by estimating the consumer surplus values resident anglers derived from participating in their sport. It was estimated that the average value of a resident angler day was $20.80 with a total value during 1985 of $89.1 million. The value of nonresident angling was found by estimating the increase in provincial income resulting from the expenditures of nonresident anglers. The average value of a nonresident angler day was estimated to be $24.40 for a total 1985 value of $11.5 million. Together resident and nonresident angling provided British Columbians with an estimated net economic value of $100.7 million during 1985. Note that this annual value represents the value of the freshwater sport fishery alone and not the total value of British Columbia's freshwater fish resources. Any commercial values or non-use values British Columbians derive from the fish resources would have to be included in order to determine the total value of the fish resources.

Lirette, M.G. and R.S. Hooton. 1988. Coded-Wire Tag Recoveries from Vancouver Island Sport Caught Steelhead, 1982-1986. Fisheries Management Report No. 92. 20 p.

Hatchery-reared steelhead trout (Salmo gairdneri) released into various streams on Vancouver Island between 1979 and 1983 were adipose fin-clipped and coded-wire tagged (C.W.T.). Sport anglers, who harvested the

who harvested the returning adult steelhead, were encouraged to submit the fish's head to depots located throughout the Island.

Between 1982/83 and 1985/86 steelhead anglers harvested a portion (23%) of the hatchery steelhead they caught and voluntarily returned heads from 13% of the fish they killed. A total of 1660 heads were recovered from 17 watersheds on Vancouver Island. The heads represented 0.11% of the total coded-wire tags released. Depending on the stream stocked, each adult C.W.T. recovered represented 40 to 200 dollars in tagging costs.

Significant numbers of marked steelhead were caught in streams other than were they were released as juveniles. For six study watersheds, the straying rate averaged 9.6% and ranged from 4.3% for streams where incubation and rearing was on-site to 32.7% for smolts outplanted to a receiving stream. Depending on the recovery stream, stray steelhead (non-indigenous) made up varying proportions (0.44%) of the total hatchery returns. Coded-wire-tagged steelhead were recovered form eight unstocked watersheds.

Fisheries management implications of hatchery steelhead production and assessment are discussed.

FISHERIES TECHNICAL CIRCULARS

Lirette, M.G., R.S. Hooton, and W.R. Olmsted. 1985. A Summary of Wild Steelhead Smolt Enumeration and Habit Productivity Studies at Quinsam River, 1976-1984. Fisheries Technical Circular No. 67. 16 p.

Emigrant steelhead parr and smolts were enumerated at the Quinsam River counting fence by the Ministry of Environment and the Department of Fisheries and Oceans from 1976 to 1984. Total emigration during each of these years was calculated by mark/recapture. Age, length and weight data were collected from subsamples. Estimated mean numbers of steelhead parr and smolts emigrating from the Quinsam River were 14,446 and 6,975, respectively during the years of trapping. Smolt ages 2. and 3. comprised the majority of the sample, and age 2. was numerically dominant. Estimated smolt numbers were compared with the yield predicted by the Ministry's production model developed for Keogh River. This model overestimated Quinsam River smolt production by approximately 75 percent. Smolt yield resulting from outplanting above impassable barriers was slightly over 2 percent and represented minimal steelhead production. Factors which affected estimated parr and smolt production, and management implications are discussed.

Barrett, D.T. and G.T. Halsey. 1985. Fisheries Resources and Fisheries Potential of Williston Reservoir and its Tributary Streams. Volume I: Fisheries Resources and Fisheries Potential of Williston Reservoir. Fisheries Technical Circular No. 68. 40 p.

Fourteen species of fish were collected from the reservoir. Kokanee (Oncorhynchus nerka) were not previously recorded from the immediate reservoir area, but a few individual females were collected from each basin in 1974 and 1975. Out of a total of about 15,000 fishes collected during this study, not a single specimen of northern pike (Esox lucius) was taken from any of the sampling stations in the reservoir.

The smallest total catch per unit effort was probably an indication that the lowest productive capacity was in the Finlay Basin; larger total catches from the Peace and Parsnip indicated about 1.2 times greater productive capability in those basins compared to the Finlay.

Lake whitefish, the dominant species in the reservoir, made up the greatest proportion of the catch at all but 2 stations, both in the Finlay basin. At these two stations, relatively large numbers of sports fish (Dolly Varden and rainbow trout) were found.

Newly introduced species like kokanee will probably alter the relative abundance of species in the reservoir as time progresses and as the nutrient dynamics of the reservoir approach stability.

The predicted yield of about 80,000 kg/yr for a sustained yield of sports fish indicates a capability for increased harvest. Actual yields will probably be considerably lower than this estimate because of the detrimental effects of fluctuating water levels and decreases in productivity as the reservoir ages.

Bruce, P.G. and P.J. Starr. 1985. Fisheries Resources and Fisheries Potential of Williston Reservoir and its Tributary Streams. Volume II: Fisheries Resources Potential of Williston Lake Tributaries - a Preliminary Overview. Fisheries Technical Circular No. 69. 101 p.

In 1975, a study of the Williston Lake fisheries resource was initiated by the Fisheries Research and Technical Services Section, B.C. Fish and Wildlife Branch. This study was one component of the Williston Potentials Study co-ordinated by the Environment and Land Use Committee (ELUC) Secretariat. An integral part of the fisheries study was to survey streams in the reservoir watershed. The two major objectives were to:

1. Locate and describe important spawning ares in tributaries and evaluate reproductive and rearing capacity for stream resident and reservoir fishes and

2. Determine fish species diversity and distribution.

Bruce, P.G. and P.J. Starr. 1985. Photo-Documentation of Williston Lake Tributaries for the 1975 Assessment of Fisheries Resource Potential. Fisheries Technical Circular No. 69-A.

In 1975 a study of the Williston Lake fisheries resource was initiated by the Fish and wildlife Branch. This study was one component of the Williston Potentials Study. During surveys of Williston Lake tributaries (Fig. 1) in the Parsnip (Fig. 2), Finlay (Fig. 3) and Peace (Fig. 4) basins of Williston Lake, numerous photographs were taken. These pictures document various characteristics; e.g., streambed composition, flow character, streambank and upland disturbance, falls, rapids, effects of drawdown, erosion, presence of spawning, rearing and overwintering habitats, beaver dams, access, net sampling locations, and reach attributes. Because of the large numbers of photographs involved, a supplementary report was the most efficient format in which to present this ancillary information.

For a more detailed description of reach characteristics, sampling sites, fish species presence and location, the reader is referred to Fisheries Technical Circular No.69 entitled "Fisheries Resource Potential of Williston Lake Tributaries" (Bruce and Starr 1985).

Dixon, B.M. 1986. Age, Growth and Migration of White Sturgeon in the Nechako and Upper Fraser Rivers of British Columbia. Fisheries Technical Circular No. 70, 27 p.

Data from a three-year radio tagging study of white sturgeon (Acipenser transmontanus) in the Nechako River was consolidated with all other available information of white sturgeon in the Omineca area. The compiled records were compared with the fisheries literature on this species in order to identify the major gaps in our knowledge of the resident sturgeon population and to facilitate a review of the management of the Omineca sturgeon.

The information available on Omineca sturgeon showed little discrepancy with sturgeon populations elsewhere, except that this northerly population appears to grow slower and mature later than coastal or southerly populations. The length to weight relationship of white sturgeon suggests that more efficient utilization of the weight potential could be achieved by increasing the minimum size limit of 100 cm by 20 cm to 120 cm. Significant weight gain does not occur until an individual reaches about 120 cm fork length which is at about age 21 for Omineca white sturgeon. The maximum size limit of 200 cm is necessary in order to maintain a spawning stock "reservoir". Total harvest levels should be regulated conservatively owing to the slow growth exhibited by this species and the consequential slowness of the population to recover from overharvest.

Billings, S.J. 1986. Steelhead Harvest Analysis, 1984-85. Fisheries Technical Circular No. 71, 83 p.

For the past nineteen years, at the end of the angling licence year, a questionnaire has been sent to fishermen who have angled for steelhead in British Columbia. Information was requested on their fishing activity and catch success for incorporation into the Steelhead Harvest Analysis. Over this time there have been considerable changes in licence sales, the number of days spent fishing and provincial catch.

In the 1984-85 season, 23,236 steelhead angling licences were sold, approximately 10% of which were to nonresidents of British Columbia. A questionnaire was sent to 63% of licencees, and a response was received from 57% of those contacted. Of the respondents, 77% fished for steelhead at least once and, of the active anglers, 62% were successful in landing a fish.

The provincial steelhead catch has increased significantly in recent years with this year's catch of 147,838 fish surpassing any previous records. The increase in catch is a combined result of increased stock abundance and repeated captures of released fish. Catch per angler day for the province was 0.73. Reduced possession quotas as well as steelhead release regulations have resulted in a decrease in the steelhead harvest (number of fish kept), dropping from 63% in 1970-71 to 13% in 1984-85.

Of the active anglers, 40% kept between one and five fish and 3% kept more than five fish. Angling effort and steelhead catch increased substantially in the Lower Mainland region, particularly on the Chilliwack/Vedder River which claimed the most fish caught (26,590) followed by the Stamp River (8,816). Reported catch on the Cowichan, Thompson, Dean and Yakoun rivers also showed marked increase over the previous year. Vancouver Island continued to report the highest number of steelhead caught in any region. Hatchery fish, caught primarily on Vancouver Island on the Lower Mainland, comprised approximately 20% of the total provincial catch with a reported harvest ratio of 25%, compared to 10% for wild fish.

Carswell, L.B., R.S. Hooton and V.A. Lewynsky. Campbell/Quinsam River Creel Surveys, 1975-76 to 1979-80. 1986. Fisheries Technical Circular No. 72. 16 p.

The Campbell/Quinsam River system was surveyed from 1975-76 to 1979-80 to assess the effects of steelhead production from the Quinsam Hatchery on the winter steelhead fishery and to compare estimates obtained by the on-site creel survey with those calculated by the annual mail survey (Steelhead Harvest Analysis). Angler use, among the most intense in the province, was consistently higher on the Campbell River, but tended to decrease as use increased on the Quinsam River. An increase on angler use of the Quinsam River occurred after 1977-78 but the estimated increase may not necessarily reflect real changes in either of the parameters. Possible confounding effects are discussed.

Estimates of angler-days by the mail survey appeared to be less biased than those calculated by the on-site creel survey. Estimates of catch rates and catch by both survey methods were probably inflated.

There was little evidence to support concern among winter steelhead anglers that a spring "smolt fishery" was adversely affecting adult returns.

No detectable relationship was evident between the time or size of hatchery smolts released and subsequent adult catch.

Clark, B.J. and A.R. Facchin. The 1984 Chilliwack-Vedder River Steelhead Creel Survey. 1986. Fisheries Technical Circular No. 73, 19 p.

During a steelhead creel survey conducted from January to April 1984, 770 anglers were interviewed and 122 instantaneous counts were completed. An estimated 11,798 angler days (4.2 hours per angler day) were spent fishing for 4,960 steelhead (0.42 fish per day), 29% of which were hatchery fish. A total of 393 fish were killed, representing 8% of the total catch.

The 1984 creel survey was compared to the 1983/84 Steelhead Harvest Analysis questionnaire which sampled a slightly different time period. The questionnaire estimate of effort was 30% greater than the creel survey estimate. That difference is consistent with comparisons between the questionnaire and other creel surveys. However, the questionnaire estimate of total kill was 55% greater than the creel census estimate representing a much greater than average difference. The average difference between the questionnaire estimates and estimates from the 1984 and 1985 creel censuses indicate that the questionnaire overestimates effort by 36% and total kill by 48% on the Chilliwack-Vedder River.

Lirette, M.G., R.S. Hooton, and V.A. Lewynsky. Preliminary Steelhead Production Capability Estimates for Selected Vancouver Island Streams. 1987. Fisheries Technical Circular No. 74. 23 p.

Steelhead smolt production capabilities were estimated for 17 Vancouver Island watersheds using two preliminary yield models developed from research conducted on Keogh River (Slaney MS 1981). Habitat measurements for the refined model were obtained from low elevation aerial photographs. Cost and benefits of aerial photographs relative to conventional ground surveys are discussed.

The two models predicted average smolt yields of 0.021 and 0.023 smolts per meter squared for Vancouver Island streams. Steelhead survival rates, derived from the Keogh River (Ward and Slaney MS 1984), were applied to the smolt yield prediction to estimate average run size and escapement requirements for each stream.

The accuracy of model predictions could not be determined in the absence of empirical measurements of smolt yield from a variety of streams. A general comparison was made, however, between predicted run size and angler catch (Steelhead Harvest Analysis 1971-86). These comparisons suggested that some streams including Little Qualicum, Gold, Cowichan, Englishman, Big Qualicum and Campbell rivers were near carrying capacity, while other streams including Tsolum, White, Chemainus, Sooke, Koksilah and Nimpkish rivers appeared to have severely depressed steelhead populations.

Recommendations on model improvements and management are presented.

Tsumura, K. and J.M.B. Hume. A Comparison of Precociousness in Three Graded Size Classes of Hatchery-Reared Rainbow Trout (Salmo gairdneri). 1986. Fisheries Technical Circular No. 75, 10 p.

Growth and maturation rates of hatchery reared juvenile rainbow trout (Salmo gairdneri, Pennask Lake stock) were compared in two groups of fish sorted into three size classes (small, < 70 mm; medium, 80-94 mm; large $\geq$ 115 mm). One group consisted of progeny from four-year-old virgin spawners

(selected) and the other, from the annual egg collection conducted by Summerland Trout Hatchery (unselected) from mainly 3 year old spawners. Trout were reared in a hatchery from May 5 to October 29, 1984 at 15°C with a food ration of 2% of body weight per day under simulated natural photoperiods.

For selected and unselected groups combined, the proportion of mature males averaged 1.7%, 10.9% and 49.2% for the small, medium and large size classes respectively. Grading is suggested as a technique to decrease the number of precocious males being stocked into quality lakes. There were no significant differences in male maturation rates between the selected and unselected groups for the three size classes.

Billings, S.J. 1987. Steelhead Harvest Analysis, 1985-86. Fisheries Technical Circular No. 76, 37 p.

For the past twenty years at the end of the angling licence year, a questionnaire has been sent to a sample of anglers who fished for steelhead in British Columbia. Information was requested on their fishing activity and catch success for incorporation into the Steelhead Harvest Analysis. Over this time here have been considerable changes in licence sales, the number of days spent fishing, catch and release of steelhead and regulations.

In the 1985-86 season, 25,619 steelhead angling licences were sold, 12% of which were to nonresidents of British Columbia. Questionnaires were sent to 63% of licencees and a response was received from 57% of those contacted. Of the respondents, 77% fished for steelhead at least once and, of the active anglers, 59% were successful in landing a fish.

The provincial steelhead catch has increased significantly in recent years. This year's catch of 145,344 fish was slightly less than the previous years record high. Recent increases in catch are a combined result of increased stock abundance and repeat captures of released fish. Catch per angler day for the province was 0.68. Reduced possession quotas as well as steelhead release regulations have resulted in a decreased proportion of the steelhead catch being kept, dropping from 63% in 1970-71 to 13% in 1985-86.

Of the active anglers, 37% kept between one and five fish and 3% kept more than five fish. Provincial angling effort continued to increase since an all-time low in 1981-82. The Chilliwack/Vedder river reported the most fish caught (17,159) followed by Stamp/Somass (16,316) and Dean (8,868) rivers. Vancouver Island continued to report the highest number of steelhead caught in any region. Hatchery fish, caught primarily on Vancouver Island and the lower Mainland, comprised approximately 27% of the total provincial catch. Almost half of the Vancouver Island catch was of hatchery origin. The release ratio for hatchery fish averaged 78% compared to 90% for wild fish. wild steelhead release regulations were in effect throughout the 1985-86 season on all Vancouver Island and Lower Mainland streams. Temporary release times were also established on numerous rivers in the Skeena Mainland area.

R.S. Hooton, B.R. Ward, V.A. Lewynsky, M.G. Lirette and A.R. Facchin. Age and Growth of Steelhead in Vancouver Island Populations. 1987. Fisheries Technical Circular No. 77. 39 p.

This report summarizes life history characteristics of winter and summer runs of wild and hatchery steelhead (since 1952) based on scale analysis. Where possible, annual growth rates and age structures were summarized for each stream and hatchery. To back-calculate lengths from scale measurements, the natural logarithm of scale radii vs the natural logarithm of body length for fish > 45 mm to adult size was used in the Fraser-Lee back-calculation procedure. Separate regression equations were calculated in systems with sufficient data and for wild and hatchery fish.

Condition factors were highest for wild winter runs, followed by hatchery winter runs, then wild summer runs. Wild winter run fish were mainly 2.2, most wild summer runs were 2.3 and 3.3 at spawning. Winter runs had a higher incidence of repeat spawning repeat spawning was higher among females than males.

Mean back-calculated length at smolting for 6 individual river systems ranged from 173 to 185 mm. Mean back-calculated smolt lengths from systems where separate regressions were not available ranged 132 mm (Nimpkish River) to 177 mm (Little Qualicum River).

Back-calculated smolt length increased with freshwater age, and adult length increased with ocean age. Larger smolts tend to have an earlier age-at-return. Back-calculated smolt and ocean age sizes indicated variation in marine growth from 1952 to 1982, mainly evident in the growth from smolting to sea age 1 and from sea age 1 to sea age 2.

Recommendations for aging and back-calculation procedures are included with a discussion of limitations to scale analyses.

Ashley, K.I. 1987. Artificial Circulation in British Columbia: Review an Evaluation. B.C. Fisheries Branch Technical Report No. 78, 34 p.

Artificial circulation in British Columbia started at Corbett Lake in the early 1960's and progressed through an experimental period at Yellow Lake (1976-1979) before developing into a full scale program in the 1980's. A review of twenty-t e circulation projects identified site selection (infrequent winterkill), equipment (hose kinking, diffusor design, compressor and blower breakdown), operation (maintenance and seasonal scheduling) and evaluation (oxygen concentrations, fish survival and angler response) as the most common problem areas. Benefit-cost analysis was used to assist in evaluating the cost effectiveness of artificial circulation. The average benefit-cost of a sub-sample of 10 Kamloops area artificial circulation projects was 3.5 for electric nits and 2.4 for diesel units under ideal conditions. Actual benefit-cost ratios may be lower due to infrequent

winterkill and equipment and operational problems. The principal conclusion from the benefit-cost analysis is that site selection is the most important factor influencing the potential cost effectiveness of an artificial circulation project. Future research possibilities are outlined in the fields of physical, chemical and biological limnology and engineering. Nine recommendations are given ranging from maintenance suggestions to the use of a standard benefit-cost model to initially evaluate future artificial circulation proposals.

Stone, Michael. British Columbia Freshwater Results of the 1985 National Survey of Sport Fishing. 1988. Fisheries Technical Circular No. 79. 104 p.

The British Columbia freshwater portion of the 1985 National Survey of Sport Fishing in Canada was a cooperative effort of the provincial Ministry of Environment and Park's Recreational Fisheries Branch and the federal Department of Fisheries and Oceans. The survey was conducted by mail using a 2.4% random sample of 1985 freshwater angling licence holders. The survey revealed that of the 360,139 licence holders, 87.3% or 314,262 anglers were active during 1985. Of the active anglers, 77% were B.C.'s residents and 23% were nonresidents. The 71,561 active nonresident anglers were almost equally divided between nonresident Canadians and nonresident aliens.

It is estimated that anglers fished a total of 4,754,000 days during 1985. Resident anglers accounted for 90% of this activity, with nonresidents providing the remaining 10%. On average, a resident angler spent 17.6 days fishing, while a nonresident spent 6.6 days. Anglers spent 70.5% of their angler days fishing on lakes and only 29.5% on rivers and streams.

Total angler catch during 1985 was 9,395,500 fish of which they retained 62% or 5,815,400 fish. Rainbow trout accounted for 58% of total catch, followed by kokanee with 14%, and cutthroat trout with 9%. All other species taken together accounted for less than 19% of total catch. On average, anglers caught 1.98 fish per angler day although nonresidents were more successful (2.76 fish per day) than were residents (1.98 fish per day).

Angling remains a predominantly male activity, with men comprising 79% of active resident anglers and 83% of active non-resident anglers. Active resident anglers made up 10.7% of the general B.C. population over 15 years of age, and male resident anglers made up 17.3% of the male population. Within the province, the male participation rate varied, reaching a high of 44% in the Cariboo region.

The trends in angling licence sales and activity showed strong growth throughout the decade of the 70's, followed by a sharp drop in the first half of the 80's. However, the decline appears to have stopped during 1985, and a return to increasing levels of angling activity has begun. Additionally, there has been a shift in the proportion of nonresident anglers from nonresident aliens to nonresident Canadians. A major reason for this shift was the large growth in the population of Alberta, whose citizens make up the bulk of nonresident Canadian anglers.

Tsumura, K. and V.E. Blann. 1988. Fishery Development in Barren, Winterkill Lakes. Fisheries Technical Circular No. 80. 8 p.

Three graded size groups (mean weights of 5.9, 11.1, and 20.4 g) of age 1 rainbow trout (Salmo gairdneri) were stocked in a barren, winterkill lake in early May to evaluate the effects of size-at-stocking on the incidence of early maturing males and on growth. Growth rates over a 169-day period were 2.1, 2.0, and 1.9% per day for small, medium, and large size grades. Mean weights in late October were 208.6, 329.7, and 495.7 g for the small, medium, and large size grades, respectively.

Significantly, more males occurred in the large size grade. The sex ratios were 0.7:1, 1.2:1, and 2.1:1 males to females for the small, medium and large grades. Rates of male early sexual maturation were similar (83.8, 93.4 and 87.3%) for all size grades. Consequently, precociously mature males comprised 35, 52, and 60% of the small, medium, and large size grades in the fall. Relative survival rates were 20, 32, and 48, respectively.

These data suggest a means of separating and utilizing precociously-maturing male trout. Large size grade juvenile rainbow trout stocked into productive, barren, winterkill lakes in the spring will be predominantly early maturing males, and all will be a catchable size by fall.

Billings, S.J. 1988. Steelhead Harvest Analysis, 1986-87. Fisheries Technical Circular No. 81, 44 p.

Since 1966-67, at the end of the angling licence year, a questionnaire has been sent to a sample of anglers who fished for steelhead in British Columbia. Information was requested on their fishing activity and catch success for incorporation into the Steelhead Harvest Analysis. Over this time there have been considerable changes in licence sales, the number of days spent fishing, catch and release of steelhead, and regulations.

In the 1986-87 season, 32,721 steelhead angling licences were sold, 12% of which were to nonresidents of B.C. Questionnaires were sent to 54% of licencees and a response was received from 55% of those contacted. Of the respondents, 76% fished for steelhead at least once and, of the active anglers, 61% were successful in landing a fish.

The provincial steelhead catch has been increasing significantly since 1980. This year's catch of 188,417 fish was a record high. Recent increases in catch are a combined result of increased stock abundance and sizeable returns of hatchery fish to some rivers, as well as repeated captures of released fish. Provincial angling effort was also at an all time high of 279,505 angler days. Catch per angler day for the province was 0.71. The Chilliwack/Vedder River was, once again, the most heavily fished stream in the province with 67,315 angler days. Angling effort on this river nearly doubled over the previous year and generated more than half of all steelhead fishing activity in the Lower Mainland.

Reduced possession quotas as well as steelhead release regulations have resulted in a decreased proportion of the steelhead catch being kept. The ratio of fish kept has dropped from 63% in 1970-71 to 13% in each of the last three years. Of the active anglers, 36% kept between one and five fish and 4% kept more than five fish.

The Chilliwack/Vedder River reported the most fish caught (31,636) followed by Stamp/Somass/Sproat (15,973), Bulkley (10,897), Skeena (10,683) and Dean (7,845) rivers. Vancouver Island reported the highest number of steelhead caught closely followed by the Skeena Mainland and Lower Mainland areas. Hatchery fish comprised 27% of the total provincial catch. Almost half of the Vancouver Island and Lower Mainland catch was of hatchery origin. The release ration for hatchery fish averaged 74% compared to 91% for wild fish.

Wild steelhead release regulations were in effect throughout the 1986-87 season on all Vancouver Island and Lower Mainland streams. Due to unexpected poor returns to the Fraser, Thompson, Chilcotin and Chilko rivers, an emergency steelhead release regulation was instituted on October 1, 1986, to help increase the spawning escapement. Steelhead release was also in effect on numerous Skeena area rivers.

Lirette, M.G. and R.S. Hooton. 1988. Telemetric Investigations of Winter Steelhead in the Salmon River, Vancouver Island, 1986. Fisheries Technical Circular No. 82. 21 p.

The freshwater migration behaviour of winter-run steelhead (Salmo gairdneri) was studied on the Salmon River (Vancouver Island) between January and June, 1986. Radio telemetry was employed to monitor in-stream movements and to determine time and location of spawning. Between January 30 and May 7, 1986, 217 steelhead were captured by angling and beach seining in the Salmon River. Sixty-one fish were held for broodstock, twenty-eight were radio tagged, thirty-four were anchor tagged, and the remainder were released untagged. The mortality rate from angling was 5.7% (11 of 192 fish caught). Twelve (19%) of the tagged steelhead (four radio-tagged and eight floy-tagged fish) were recaptured by angling. Of 28 radio-tagged steelhead, 23 (82%) were tracked through spawning and 20 (71%) were followed through emigration. Telemetric monitoring showed that tagged steelhead moved quickly through the lower river (0 - 25 km) and occupied stream reaches presently closed to all angling. Radio-tagged steelhead (n = 4) migrated through a canyon located at 38 km and confirmed the successful removal of a migration barrier. Tagged steelhead spawners were distributed throughout the upper watershed, including the mainstem from 25 to 45 km, the Memekay River from 29 km (confluence with the Salmon River) to 40 km, Northfork Memekay River and Cooper Creek. The telemetric monitoring of steelhead tagged in February and late March suggested the existence of two stocks of fish. Fish tagged early utilized the Salmon River mainstem above the Memekay River, spawned during late March and early April, and emigrated between April 15 and May 15, 1986. Steelhead tagged in late March utilized the Memekay River and the Salmon River below the Memekay confluence (29 km), spawned during late April and early May, and emigrated in late May. Implications of the study results to habitat protection, angling regulations and broodstock requirements are discussed.

Parkinson, E.A. 1988. Long Term Data Collection on Kokanee from Large Lakes; Does it Make Sense? Fisheries Technical Circular 83: 29 p.

A fishery manager needs data on individual stocks to: identify and understand the causes of fisheries problems, evaluate potential solutions and ensure continued support by documenting progress.

The goals of management define the data needs. In the case of kokanee management, I have assumed that the goals are to maintain or increase both angler effort and the quality of the angling experience while preserving fish stocks for the future. A basic data collection program should include indices of effort, fish size and angler CPUE to provide information on the fishery, and indices of fish density, growth rate and age at maturity to document the effects of management actions on fish populations. Decisions on specific actions including fishery regulation, habitat improvement or fish culture should not be made without the information necessary to guide those decisions.

The value of the fishery was used as a starting point for estimating a "reasonable" cost for a data collection program. For Kootenay and Okanagan lakes the value of each fishery is about $1,000,000 per year. In some commercial fisheries, management costs are about 30% of the value of the fishery. In addition, modest gains of 10% to 20% in yield and effort can be expected under an improved management regime. Expenditures of $50,000 to $100,000 per year therefore appear to be reasonable and are more than adequate for a basic data collection program.

Trawl and echosounding data from Kootenay and Okanagan lakes are summarized in an appendix as an example of the initial data points in a time series. Length and weight at age, length frequency distributions, age composition, catch per unit effort, spatial and temporal variation in density, and total population data are presented in a series of graphs and tables. Information on the fishery (boat counts, angler CPUE, fish size) is not included in this report but will be incorporated into future summaries.

FISHERIES PROJECT REPORTS - RESEARCH

Hume, J., K. Tsumura and K. Ashley. A Preliminary Comparison Between Premier and Duncan Rainbow Trout Stocks in a Lake Containing Redside Shiners. 1986. Fisheries Project Report No. RD-1. 3 p.

Rainbow trout stocked into lakes containing redside shiners are often smaller and in poorer condition than rainbow stocked into rainbow mono-culture lakes. In an attempt to improve on the performance of rainbow in these lakes, we stocked fish from a known piscivorous stock (Duncan River) into a lake (Garcia) containing redside shiners. Fish from Premier stock were also stocked for comparison. Fish were sampled in the fall of 1986 using multiple-mesh-size gill nets. Of the 58 fish caught 64% were from the Duncan stock, significantly greater than the expected 50%. Five of the Duncans had shiners in their gut but none of the Premiers caught had any. Overall, there was no difference in weight and length of the two stocks but trout with fish in their guts averaged 100 g heavier than those without. Sampling will continue in 1986.

Hume, J., L. Lemke and K. Tsumura. Comparison between Pennask and Premier Rainbow Trout Stocks in Lakes with Different Productivities. 1986. Fisheries Project Report No. RD-2. 7 p.

The performance of two wild rainbow trout stocks (from Pennask and Premier lakes), which are a major source of fish for the hatchery lake stocking program, were compared in three lakes of different productivity. Pennask Lake is a low productivity lake with a large fish population, while Premier Lake is more productive. Equal numbers of both stocks were released into the experimental lakes in May 1985 at a mean weight of 4.6 g for the Premier fish and 7.0 g for the Pennask fish. Fish were sampled in October 1985 at age 1+. Overall, fish averaged 20 g in Headwaters #3, 79 g in Yellow and 138 g in Madden. Premier fish were significantly larger than Pennask in Yellow and Madden Lakes, but were smaller in Headwaters #3. Similarly, there was no difference in survival between the two stocks in Yellow and Madden, but Pennask survived significantly better in Headwaters #3, although sample sizes were low in this lake. The data to date suggests that Pennask fish would do better in low productivity lakes and would be the stock of choice for these lakes when fish allocations are being made.

Tsumura, K., T. Johnston and E. Parkinson. Methodology for the Evaluation of Rainbow Trout Broodstocks for Coarse Fish Lakes. Broodstock Development Project. 1988. Fisheries Project Report No. RD-3. 19 p.

Standard methods for selecting, collecting, and evaluating potential broodstocks for British Columbia trout hatcheries are presented. Broodstocks

which may alleviate management problems, such as stocks for coarse fish lakes, are of prime concern. In order to evaluate these stocks without bias, biological and physical data must be systematically collected using standardized methods and recorded on standard data sheets for ease of analysis and interpretation.

Criteria for selecting broodlakes and broodfish, and the information required for evaluating the progeny of the stocks are presented.

Tsumura, Kanji and Jeremy M.B. Hume. Post-Spawning Growth and Relative Survival of Precocious Rainbow Trout (Salmo gairdneri). 1987. Fisheries Project Report No. RD-4. 9 p.

Precocious and non-precocious 2-year-old rainbow trout (Salmo gairdneri) were observed for growth and relative survival for two consecutive years in a lake which was initially barren. In the first year, post-spawning precocious males weighed 39% more than the non-precocious fish when sampled as 2+ fish in the fall. In the second year, postspawning precocious males weighed 7% less than the non-precocious fish.

There was no difference in relative survival of the post-spawning precocious males compared to the non-precocious fish in the first year, but in the following year, relative survival of precocious males was 54% of non-precocious fish.

Although results are somewhat contradictory, they indicate that precocious males may not contribute significantly to a sports fishery and should be reduced or eliminated from a hatchery stocking programme. This study will be repeated in 1988.

Blann, V. and K. Tsumura. 1988. A Comparison of Floy Fingerling and Internal Tags Used in Marking Rainbow Trout (Salmo gairdneri). Fisheries Project No. RD-5 5 p.

Effectiveness of Floy FTF-69 fingerling tags and two types of internal body cavity tags was compared. Tag loss between the FTF-69 Floy fingerling tagged group and the two groups of internally tagged fish was not significantly different after 16.5 weeks. Tag retention was 100% in a test group having yellow internal tags, and 94.3% for a group supplied with blue tags having metal inserts. Floy fingerling tagged fish also retained 94.3% of their tags. No mortalities occurred as a result of tag application in any of the test groups.

Final lengths and weights were significantly different ($P < .05$) between the Floy fingerling and blue metal tagged fish.

General observations upon tag recovery revealed a high incidence (71%) of inflammation surrounding the Floy fingerling tag site. Wounds from the internal body cavity tage injections healed without complications.

Ward, Bruce R. 1988. Trends and Forecasts from Winter-Run Steelhead at the Keogh River. Fisheries Project Report No. RD-6. 8 p.

Trends in Keogh River smolt production and adult returns were utilized to develop predictive models for forecasting run sizes. A broad variation in smolt (6 fold) and adult (13 fold) numbers has been observed since 1975. Similarly, age structure of smolts and adults and marine survival rates have varied. It was shown that variation in adult return was related to smolt number, age and size. These relationships were used to estimate about average wild returns (approx 1000 fish) over the next two seasons. Comments on hatchery returns to the Keogh River are included.

Ashley, K.I., E. Parkinson and A.F. Tautz. 1986. Broodstock and Research Lake Opportunities in Southern Interior B.C. Fisheries Report No. RD-7. 17 p.

The broodstock lakes program was initiated by the Fisheries Branch in the spring of 1984 for the purpose of identifying privately-owned lakes in southern B.C. for potential broodstock and research opportunities. The program has been coordinated by the Fisheries Research and Development Section, and has focused on lakes in the Thompson-Nicola and Okanagan areas with an initial examination of southern Cariboo area lakes. The actual surveys were conducted in three phases; Merrit area (Phase One), Douglas Lake ranch area (Phase Two), and southern interior region (Phase Three). A number of lakes were identified in each phase and at least six lakes are suitable for broodstock purposes and eleven lakes suitable for research purposes. The six broodstock lakes could produce a total of 2.9 million eggs per year. Future efforts on the broodstock/research lake program should focus on program direction and field surveys.

Ward, B.R. 1988. Project Proposal: Evaluation of a Method to Enumerate, Size Sample, and Separate Fish Species Using Video/Computer Equipment. B.C. Fisheries Project Report No. RD-8.

Fisheries biologists are frequently faced with the task of enumerating and sampling large quantities of fish, often with the added complexity of mixed stocks and/or species. A number of devices have been introduced to speed the process of fish counting beyond that achieved by manual methods. The most common of the electronic methods has been side-scan sonar, evaluated by Johnston et al. (1986). The use of radar has currently generated interest in fisheries but is still in the developmental stage. Smith-Root Inc. and Pulsar Electronics Inc. supply counting tunnels, the latter currently used at the Recreational Fisheries Branch Pennask Creek facility.

The combination of rapid electronic counting and size measurement in one instrument is rare. Measuring boards wired to computers have been developed (McAllister and Planck, 1981) but one must physically handle the fish to capture the data. Pisces Computing Ltd. is currently developing a method of both counting and measurement by using a video camera attached to a recorder and connected by a frame grabber to an IBM computer. The fish are untouched but for possible dipnetting. This video/computer combination is unique and may be the first to successfully combine counting and measurement of fish with minimal or no handling.

A description of the Pisces equipment and methodology is contained in the unsolicited proposal (enclosed as Appendix 1). This report describes the experimental procedure to compare the acquisition of data at two fish fences by manual methods with the collection of data with video/computer. The proposal is in two parts:

I.) comparison methods at the Salmon River fence to test count and size information from steelhead smolts and,

II) comparison methods at the Keogh River fence to test the ability to accurately separate species in the smolt migration.

The final report will be prepared as a manuscript submission to the North Am. J. Fish. Mgmt. (Ward, Irvine, Teti, Cousins).

Howard Paish & Associates. 1986. A Review of Stocking Juvenile Resident Trout in Streams. B.C. Fisheries Project Report No. RD-9. 13 p.

A comprehensive literature search and agency contact on the stocking of subcatchable (juvenile) resident trout in streams revealed only limited quantitative information on stocking procedures, survival and growth that would aid in the development of a stream stocking program for British Columbia.

Few agencies monitor the growth and survival of stocked fish, as many stocking programs are solely for put-and-take fisheries where these are not important considerations.

Where monitoring has been carried out, considerable variability is reported in overwinter survival and survival to capture of subcatchable fingerlings and yearlings; probably due to the wide range of conditions into which these various stockings have taken place.

Most reported successful stocking has been in productive streams, and several agencies limit their stocking to those streams which offer good potential for growth.

Several agencies report little confidence in stocking small fingerlings (less than 6 cm); preferring larger fingerlings (over 10 cm)

stocked in the fall, or limiting fingerling stocking to special situations such as restorative programs where sufficiently high survival can be guaranteed.

Yearling trout (generally larger than 15 cm) have shown higher survival; being able to overwinter more successfully and favorably compete with or avoid predation from coarse fish.

Stocking rate formulae have been developed by several agencies. The system based on stream rearing capability (i.e. New York) may have the greatest application for British Columbia.

Broad dispersal of stocked fish has been recommended as an effective way to maximize growth and survival through optimal use of available habitat.

Rosenau, M.L. and P.A. Slaney. 1983. A Preliminary Capability Model for Estimating Standing Crop of Resident Salmonids in Streams. B. C. Fisheries Project Report No. RD-10. 19 p.

A preliminary habitat capability model (HCM) for predicting standing crop (kg/ha) of resident trout and char in streams was constructed with data sets from 38 streams in western North America. Two variables were incorporated in the final model which was derived from 24 complete data sets. Niney-two per cent of the variance in standing crop was explained by the regression equation: $SC = 190 (C) + 13,900 (NO3N)^2$ where SC is standing crop in kg/ha, C is the proportion of the wetted area as cover for trout and char (Appendix B), and NO3N is the nitrate nitrogen concentration in mg/l, both measured in August to September.

Comparisons to a nine variable Wyoming model (HQI; Binns 1982) indicated HQI predictions averaged ca. 25% less than predictions from the simplified HCM. Preliminary testing using a sample of streams in British Columbia indicated that HQI was more accurate and was preferable if sufficient data is available.

Further collection of data in British Columbia is required to improve and test these capability models owing to a wide range of applications including, (1) for setting and evaluating fisheries management regulations, (2) for assessing habitat impacts, and (3) for planning and evaluating enhancement or restoration projects for resident salmonid streams.

Lewynsky, V.A. 1986. Sport Fishing Opportunities and Suspended Solid Concentrations in the Upper Nechako River with Changes in Regulated Summer Flows. B.C. Fisheries Project Report No. RD-11. 35 p.

Western Renewable Resources was retained by the Fisheries Branch of the B.C. Ministry of Environment and Parks to provide an independent

assessment of sportfishing opportunities and water quality with changes in regulated summer flows in the upper Nechako River and Cheslatta/Murray Lake system.

Angling and water conditions were examined at five flows in 1986 as recorded at a gauging station in the upper Nechako River; 62 m^3/s (June 22-24); 115 m^3/s (July 13-15) 160 (July 17-19); 189 (July 2-27); 34 (September 6-8). On average, catch rates did not change significantly between flow periods, but fishing quality and attractiveness of fishing sites declined as flows increased above 115.0 m^3/s. At 160 and 189 m^3/s many test fishing sites became difficult to fish and several sites could not be fished safely. Alternatively, navigation by jet-boat improved at flows above 62 m^3/s.

Water clarity decreased and suspended solids increased with increased flows throughout the study area, but was most pronounced in Cheslatta River and Cheslatta Lake. Secchi disk transparency decreased from approximately 6 m to an average minimum of 2.5 m at the high flows in the Nechako river. Transparency in the upper Cheslatta Lake area decreased from an average of 2.6 m in June to 0.2 m during the high cooling flows. Suspended residue concentrations followed a similar pattern and changes were most pronounced in Cheslatta River, Cheslatta Lake and the lower two reaches of the Nechako River.

General conditions of the entire study area were documented by photographic colour slides, and changes in the upper Nechako River were assessed relative to the nearby Stellako River which served as a control stream.

Hume, Jeremy. Habitat Conservation Fund, Technical Progress Report (1985-86), Salsbury Lake Fertilization. 1987. Fisheries Project Report No. RD-12. 15 p.

This is the first year of a 4-year pilot project to increase fish yields in Salsbury Lake by the addition of inorganic fertilizers. Before fertilization started the lake was ultra-oligotrophic with a TDS of 14-25 mg/L, total N levels of 240 µg/l and total P of 7 µg/l. Twenty-three $mg/l/m^2$ /week of P and 87 mg/m^2/week of N (N:P ratio = 8.5:1) were added the the lake for 19 weeks starting on May 22, 1985. Two agricultural grade granular fertilizers, ammonium phosphate (11-55-0) and ammonium nitrate (34-0-0) were poured into a floating box with a nylon cloth bottom (183 micron openings). This allowed the fertilizer to dissolve and disperse in the epilimnion. Diving observations and sampling indicated that the added nutrients remained above the thermocline and dispersed throughout the lake. There were no observable detrimental effects on water quality, parameters such as pH, alkalinity minimum 0 levels and TDS. Chlorophyll a concentrations rose from 1 $µg^2/l$ in May to over 12 µg/l in late August, while those in a nearby lake never rose above 1 µg/l. P rose from a total of 7 µg/l to 30-60 µg/l in late summer and N rose from 240 µg/l to > 300 µg/l. Fish samples were taken but not analyzed. Literature on the effects of fertilization on fish production is summarized.

Hume, Jeremy M.B. Habitat Conservation Fund, Technical Progress Report (1986-1987). Salsbury Lake Fertilization Project. 1987. Fisheries Project Report No. RD-13. 14 p.

Nutrient addition continued in the second year of a four-year pilot project at a rate of 600 mg $P/m^2/6mo$ and 2,258 mg $N/m^2/6mo$ (8.5:1 N to P atomic weight ratio). Agricultural grade fertilizers, ammonium phosphate (11-55-0) and ammonium nitrate (34-0-0) were added weekly to a floating screen bottomed (180 um) box anchored in the deep end of the lake from April 14 to September 29, 1986. The nutrients were thus held in the epilimnion while dissolving and sampling indicated that they dispersed throughout the entire surface waters. Summer phytoplankton densities averaged 8 times higher in Salsbury Lake (8.1 µg Chl a / L) than in nearby control lakes (0.8 to 1.3 µg Chl a / L). Phytoplankton started to bloom one month earlier than in 1985 when fertilization didn't start until May 22 and 1986 averaged much higher summer densities than 1985 (4.2 µg/L). Fish samples were collected for comparison of growth rates with previous years but analysis is not yet completed.

Facchin, Angelo R. 1987. Investigation of the uses of 17α-Methyltestosterone and Estradiol-17β to Eliminate or Delay Maturation of Hatchery-reared Rainbow Trout (Salmo gairdneri). Fisheries Project Report No. RD-14. 5 p.

Two groups of rainbow trout were treated with 17α-Methyltestosterone at levels expected to produce sterile fish. Neither sterilization treatment was effective at preventing maturation. At 2+ years, 40% of fish in the lower oral dosage group and 42% of fish in the higher oral dosage group were maturing.

Two groups of rainbow trout were treated with Estradiol-17β at levels expected to produce all phenotypic-female fish (genotypic males would develop as phenotypic females). Neither sex reversal treatment was effective at producing all phenotypic-female fish. At 2+ years, 57% of fish in the high oral dosage group (no steriod bath) and 42% of the fish in the lower oral dosage (with steriod bath) were phenotypic-female fish.

One group of rainbow trout was fed 3 milligrams of 17α-Methyltestosterone per kilogram of food for 90 days in the expectation of producing all phenotypic-male fish (genotypic females would develop as phenotypic males). Ninety-six percent of fish sampled from this group at 2+ years were phenotypic males. This represents a significantly different phenotypic sex distribution from that found in the control group and suggests that this sex reversal treatment was effective. Suspected phenotypic-male, genotypic-female fish were progeny tested in a subsequent project. Several of the fish crossed with normal females produced all female progeny.

Masculinized females crossed with normal females will only produce female offspring. In the case of Pennask rainbow trout (a common hatchery

brood stock in British Columbia) a greater proportion of 2-year-old stocked fish should be available to the fishery in the spring and early summer because precocious males are not present in the stocked population.

Ashley, K.I., and J.M.B. Hume. Habitat Conservation Fund, Technical Progress Report (1987-1988). Salsbury Lake Fertilization Project. 1987. Fisheries Project Report No. RD-15. 14 p.

Nutrient addition continued in the third year of a four-year pilot project, at a rate of 600 mg $P/m^2/6$ mo and 2,258 mg $N/m^2/6$ mo (8.5:1 N to P atomic weight ratio). Agricultural grade fertilizers, ammonium phosphate (11-55-0) and ammonium nitrate (34-0-0) were added weekly (May 3 to September 27, 1987) to a floating screen bottomed (180 um) box anchored in the deep end of the lake. The nutrients were held in the epilimnion while dissolving, and sampling indicated they dispersed throughout the epilimnion. Summer phytoplankton densities averaged 11-15 times higher in Salsbury Lake (11.9 µg Chl a/L) than in nearby control lakes (0.8 to 1.1 µg Chl a/L). Average chlorophyll a concentrations in 1987 (11.9 µg/L) were higher than either of the previous fertilization years (8.1 ug/L, 1986; 4.2 ug/L, 1985), suggesting the lake is becoming more productive. Fish samples were collected for comparison of growth rates with previous years but analysis is not yet completed.

Ashley, K.I. 1988. Preliminary Economic Assessment of the Salsbury Lake Fertilization Project. Fisheries Project Report No. 16. 14 p.

Benefit-cost analysis was used to provide a preliminary economic assessment of the Salsbury Lake fertilization project. The standard conditions B/C ratio for Salsbury Lake was 2.2:1 for a research leval investigation. The B/C ratio for a regional production level fertilization project was estimated at 5.2:1 when stocking costs are included and 13.1:1 when stocking costs are excluded.

Sensitivity analysis of the research level B/C model indicates the B/C ratio is relatively independent of variations in discount rate, fertilizer, labour and monitoring costs; moderately sensitive to variations in site visits and stocking costs; and most sensitive to variations in input variables influencing yield estimates, fish size, catch/angler-day, and value of an angler-day. A validity check of the B/C model suggests predicted effort and catch estimates are reasonable compared to creel surveys on two lakes in the same management region. The B/C analysis indicates a number of program adjustments are required to ensure a high B/C ratio as the program shifts from research to production level fertilization, particularly in the areas of reducing application costs, optimizing N:P ratios and P loading rates and accurately estimating fish yields from baseline and fertilized lakes.

Blann, V.E. and K. Tsumura. 1988. Rainbow Trout Broodstocks for Coarse Fish Lakes. Habitat Conservation Fund Progress Report (1988-89). Fisheries Project Report No. RD-17, 11 p.

This study summarizes the first year of a 5-year project evaluating and developing broodstocks of rainbow trout strains suitable for stocking into coarse fish lakes. Sources of potential broodstocks are identified and preliminary comparisons of two candidate strains, the Blackwater and Dean River trout, are made.

FISHERIES PROJECT REPORTS - FISHERIES IMPROVEMENT UNIT

Griffith, R.P. 1986. Rainbow Trout Production and Implications of Coho Salmon Enhancement in the Bessette Creek Drainage, Tributary to the Middle Shuswap River. B.C. Fisheries Project Report No. FIU-01, p. 43

A biophysical assessment of selected portions of the Bessette Creek drainage was conducted in August 1985. It would appear that Duteau Creek, Upper and Lower Harris Creek, and Creighton Creek are production areas of migratory trout, presumed to be Mabel Lake recruits. Duteau Creek appears to be a major source of such production. It was also the site of coho salmon fry releases for enhancement purposes in 1985. The mean sampled density in this stream was 7.57 g/m^2, the highest encountered in the study, and compared to a mean 6.2 g/m^2 in naturally recruited portions of the drainage. At the same time, trout condition factors in Duteau were the lowest of all areas sampled. It appears that naturally recruited ares may have been at or near carrying capacity in August 1985, and that the investigated portion of Duteau Creek was above such capacity. Potential jeopardy to rainbow production is discussed.

Griffith, R.P. 1986. Fisheries Assessment of the Slocan River: I: Abundance and Distribution of Catchable-sized Fish Relative to Production Potential (modelling). B.C. Fisheries Project Report No. FIU-02. 50 p.

Fourteen (14) swim surveys, totalling 26 km in length, were conducted in the Slocan River mainstem and the lowermost 1.5 km of its major tributary, the Little Slocan River. Survey counts of rainbow trout, in three size categories (<20 cm, 20-30 cm, >30 cm), were used to generate survey specific population estimates, Results indicated that the existing standing stock of rainbow in the Slocan mainstem is low (ca. 2.9 kg/ha), and compared to standing stock potential indicated by fish production models (ca.7.5-10 kg/ha), it appears that rainbow populations could be doubled or tripled in the Slocan River. Evidence also suggests that some tributaries play a major role in providing recruitment to the Slocan mainstem, where suitable substrate for successful rainbow spawning appears limited. Further investigation of current production of juvenile rainbow in (from) tributaries relative to carrying capacity in these streams should be conducted towards determining natural enhancement potential in the system as a whole.

Griffith, R.P. 1986. Fisheries Assessment of the Slocan River: II Abundance and Distribution of Juvenile Rainbow Trout and Final Enhancement Recommendations. B.C. Fisheries Project Report No. FIU-03, p. 52

In August 1986, juvenile fish populations were assessed in the Slocan River drainage, below Slocan Lake. This was the second and final year of a study to determine fisheries enhancement options for the system. Electrofishing was conducted at a total of 15 sites in the Slocan mainstem and seven tributaries. With the exception of three juvenile whitefish in Trozzo Creek, rainbow trout was the only salmonid species captured. Trout were captured at only 10 of the 15 sites sampled, and where they occurred, numbers of juvenile rainbow were generally low. Although nutrients (TDS, nitrates, phosphorus) tend to be low through the system, it would appear that low numbers of juvenile trout are best explained by a lack of recruitment, consistent with the small population of larger (adult) fish observed in the Slocan River mainstem in 1985. Fry releases to tributary streams could theoretically result in the recruitment of approximately 7,600 rainbow parr to the mainstem. Releases to the Little Slocan River, Lemon Creek, and Goose Creek could account for up to 90% of this potential. Planned mainstem stocking with yearling (or older) rainbow is supported as the most advisable enhancement option at this time.

Ptolemy, R.A. 1986. Assessment of Highway Construction Impacts and Fisheries Mitigation in the Coquihalla River Near Hope, British Columbia: Progress in 1985. B.C. Fisheries Project Report No. FIU-04, 85 p.

With support of the B.C. Ministry of Transportation and Highways, short and long-term effects of highway construction on Coquihalla River summer steelhead began in August 1985 and will continue to at least 1987. Intensive fish population and habitat investigations were focused on a 23 km section of the mainstem between Othello and Boston Bar Creek. Within this reach, several major diversions and other channel encroachments have occurred as a result of recent highway construction. Mitigation measures have been taken to reduce these impacts on steelhead habitat.

Results from monitoring in 1985 were put into perspective with eight years of pre-construction data (1977-84), collected as a result of a steelhead enhancement project under the Federal-Provincial Salmonid Enhancement Program. Juvenile rearing habitat (fry and parr) was expressed in terms of Weighted Usable Area (WUA), a standard method which predicts fish carrying capacity based on physical habitat characteristics alone. Using this approach, it appeared that two major diversions near Sowaqua Creek had reduced parr rearing capability, with little or no change in fry rearing and an overall increase in pool (adult holding) area compared to pre-construction conditions. Although the diversions feature large rip-rap bank armouring and boulder spurs, a net decrease in wetted width and average bedload particle size has impacted on parr rearing.

While suspended sediment concentrations were significantly greater at observed summer flow stages, no decrease in juvenile steelhead numbers or biomass could be directly attributed to construction-related turbidity. In addition, freeze-core gravel sampling did not demonstrate a major reduction in spawning habitat quality, although samples obtained near Boston Bar Creek did show elevated sand composition by weight.

In spite of localized habitat impacts, the Coquihalla supported record-high populations of steelhead fry and parr in 1985. In part, high juvenile abundance reflects the apparent success of ongoing stock enhancement carried out by regional fisheries managers (fry and parr stocking). Mitigation monitoring will continue until 1987 to better define the scope and duration of highway impacts on the river's steelhead population.

Griffith, R.P. 1986. Assessment of Fisheries Enhancement for Powell Lake, at Powell River. B.C. Fisheries Project Report No. FIU-05, p. 26.

In July and September 1985, an overview study was conducted to assess the potential for rainbow trout stocking in this large (ca. 12,000 ha), oligotrophic, fjord-type lake. All data suggest that fish populations are large relative to the lake's low productive potential. High numbers and biomass of older trout indicate that fishing pressure is light, and that current production levels are primarily controlled by natural phenomena. It would appear that large predaceous cutthroat trout are controlling the size of other fish species in a limited environment. Since it is speculated that a delicate balance may currently exist in the lake's biology, stocking is not recommended. Any trial releases must be small in size (1-2 fish/ha), and should not be conducted in the absence of a firm commitment to monitor the results through the sports catch and other sampling. The dominant species, cutthroat trout, should be used for any such trials.

Russell, J.R.L. 1987. Steelhead Production Characteristics of the Chilliwack-Vedder System. B.C. Fisheries Project Report No. FIU-07, Victoria, B.C. 29 p.

Steelhead trout production characteristics of the Chilliwack-Vedder system were investigated through a joint project carried out by the Fisheries Improvement Unit and regional Fisheries Branch staff from 1983-86. The principal objective was to provide sound biological direction for management of steelhead harvest on this extremely important river system. Steelhead habitat capability was defined on the basis of current production models, primarily the weighted usable area (WUA) approach.

A significant positive linear correlation between steelhead fry abundance and WUA (based on depth and velocity measurements) explained 86-99% of the variability in annual fry density. Mean adjusted density (@ WUA=1.00) ranged from 136-231 fry/100 m^2 and 232-296 g/100 m^2. Best growth slope (Iwama and Tautz, 1981) calculated was 11.1 at 136 fry/100 m^2, compared to an estimated mean water temperature of 13.5°C for the same time period.

Total mainstem area was ca. 226 ha. above the Vedder Canal. Usable width for fry was estimated at 25% based on whole stream transects and field observations. Using the fry density-WUA model, 11,000 wild adults could be produced at full rearing capacity. In addition, hatchery adult returns of approximately 5,000 should be expected from recent annual releases of 120,000 smolts.

It is recommended that mainstem fry stocking be discontinued provided spawning escapements exceed the number required to saturate fry rearing habitat. A larger harvest of marked hatchery steelhead should be encouraged to reduce potential impact on the wild gene pool. Angler density reduction and greater access to the resource might be achieved by opening the mainstem above Slesse Creek to angling. To confirm the reliability of adult escapement and juvenile standing stock relationships, annual juvenile population monitoring should continue until the summer of 1989 (completion of one life-cycle).

Tredger, C.D. 1987. Investigation of Kokanee Enhancement Opportunities in Okanagan Lake Tributary Streams. Fisheries Project Report No. FIU-08, Recreational Fisheries Branch, Victoria, B.C.

Kokanee enhancement opportunities were investigated in 3 Okanagan Lake tributaries in 1986 by the Fisheries Improvement Unit. The approach was to assess existing escapements relative to current habitat conditions using weighted useable area analysis. Use curves for calculating WUA were verified and modified using habitat and kokanee density data collected in Peachland and Powers Creeks. WUA and kokanee capacity was estimated at observed flows in Peachland and Powers Creeks, and at four modelled flows in lower Mission Creek. Current limiting factors were identified and enhancement opportunities discussed. Appropriate methodologies for future application to Okanagan tributaries were also described.

In lower Mission Creek (to Ziprick Road), a maximum capacity of 234,000 spawning kokanee was estimated at a flow of 1.42 m^3/s (22% MAD). The estimated capacity fell between the 1986 and historic maximum escapement estimates. The capacity of Powers Creek at 0.13 m^3/s (17% MAD) was estimated at 36,000 kokanee, roughly equal to the historic maximum estimates. Peachland Creek capacity at 0.26 m^3/s (65% MAD) was estimated at 15,500 kokanee, roughly half the reported historic maximum. Limiting factors in all 3 streams were largely related to substrate quality and quantity. several "generic" enhancement options are suggested, contingent on engineering advice.

Future methodologies to meet the stated FIU objectives should continue with the IFIM type approach. Advantages of this method are that it can give estimates of capacity and optimum flow, and it is applicable to multi-species. As it is relatively time consuming, the IFIM should be used to calibrate the Montana method, which can then be applied as a first cut to all streams.

FISHERIES PROJECT REPORTS - LOWER MAINLAND REGION

Usher, J.B. 1986. Skagit River Rainbow Trout (Salmo gairdneri) Tagging Study, 1984. B.C. Regional Fisheries Project Report No. LM-101. 28 p.

This study duplicates a tag-recovery program conducted on the Canadian Skagit River in 1983. One hundred and fifty-nine rainbow trout, greater than 25 cm fork length, were angled and tagged with Floy spaghetti tags from early July to the end of September, 1984. Thirty-nine tags were recovered in the sport fishery. Little fish movement was observed during the summer with a general downstream movement observed in the fall. These results are similar to the 1983 study. Data from both years suggests that fish show little movement during summer months and move downstream to Ross Reservoir in the early fall. A strong homing mechanism to the same location on the river and/or mixed resident and migratory populations is also suggested.

Scott, K.J. Angler Catch and Use Survey of Ross Reservoir and the Canadian Skagit River, 1985. B.C. Regional Fisheries Project Report No. LM-102. 35 p.

At Ross Reservoir, from June 14 to October 31, 1985, angler effort was estimated at 65,673 hours (14,550 days). An estimated 21,979 rainbow trout were caught of which 83% were harvested. The estimated total catch of Dolly Varden char, brook trout and cutthroat trout was 2,065, 421 and 24 respectively. Angler effort at Ross Reservoir was greatest during the opening week of the fishery; angler catch rates were high during the opening week and in October.

At the Canadian Skagit and Sumallo Rivers, from June 14 to September 30, 1985, angler effort was estimated at 16,548 hours (4,142 days). An estimated 3,579 rainbow trout were caught of which 2,307 (65%) were harvested. The estimated total catch of Dolly Varden char, brook trout and cutthroat trout was 56, 87, and 0, respectively. Angler effort was heaviest during June, particularly on opening weekend.

Rainbow trout tagging studies showed that only a portion of the migratory reservoir stock remained in the Skagit River to contribute to the fishery in 1985.

Whyte, I.W. 1986. Deer Lake (Sasquatch Provincial Park) Angler Survey. April to October, 1985. B.C. Regional Fisheries Project Report No. LM-104. 14 p.

ECL ENVIROWEST CONSULTANTS LIMITED conducted an angler survey at Deer Lake (Sasquatch Provincial Park) between April 1 and October 31, 1985.

The lake was surveyed ten times per month, with randomly selected samples equally divided between weekdays and weekends, and between AM and PM units.

Angler effort was estimated to be 14,380 hours (3677 angler days) for the seven-month study period, and 15,000 hours (3836 angler days) for all of 1985.

A total of 400 anglers were interviewed during the study. They caught 178 rainbow trout and 141 cutthroat trout. Of the rainbow trout caught, 35 were wild, 42 were hatchery-raised, 90 were released and 11 were kept, but their length and/or origin could not be determined. Hatchery-raised fish accounted for 55% of the rainbows caught; 44% of the trout (both species) caught were kept. The total estimated catch for rainbow trout and cutthroat trout was 3639 and 3148, respectively. Estimated harvest for rainbows and cutthroats was 1842 and 977, respectively.

Angler effort increased to June, then declined to the end of the study period, except for a small increase in September. Catch-per-unit-effort for rainbow trout peaked in June at 0.37 fish/hour, and for cutthroat trout in May at 0.48 fish/hour.

The study period exhibited fairly typical weather, except for an uncommonly long hot, dry spell which caused the lake level to drop and the water temperature to rise. Although angling success was low during this period, the lake remained popular for other recreational uses (e.g. swimming).

Deer Lake is angled mostly, and about equally, from boats and shore. The dock is also well utilized by anglers. Bait-fishing was the most common method used, however, the greatest success rate was achieved with flies.

Whyte, I.W. 1986. Deer Lake (Burnaby) Angler Survey. April to October, 1985. B.C. Regional Fisheries Project Report No. LM-105. 13 p.

ECL ENVIROWEST CONSULTANTS LIMITED conducted an angler survey at Deer Lake between April 1 and October 31, 1985. The lake was surveyed ten times per month, with semi-randomly selected samples equally divided between weekdays and weekends, and between AM and PM units.

Angler effort was estimated to be 8,300 hours (2330 angler days) for the seven month study period, and 11,100 hours (3160 angler days) for all of 1985.

A total of 268 anglers were interviewed during the study. They reported catching 53 rainbow trout. Of the trout caught, 2 were wild, 42 were hatchery-raised and 9 were released. The hatchery-raised trout included 13 for which lengths could not be determined (they had no heads, but were adipose clipped). Hatchery-raised fish accounted for 95% of the catch; 80% of the fish caught were kept. The total estimated catch and harvest for the study period were 355 and 284 fish, respectively.

Angler effort was fairly constant through the study period, with the exception of June which was very low in effort. Catch-per-unit-effort was greatest in October (0.08 fish/hour), followed by September (0.07 fish/hour) and August (0.068 fish/hour). IEC Beak Consultants Ltd. found that angling effort and catch were high in the months of February and March, indicating that angling success is likely good through the winter.

The months of June, July and August were very warm, and brought a large increase in non-angling recreational activity. Angling effort remained high in the months of July and August, which corresponded with the summer closure of public schools.

Deer Lake anglers almost exclusively use bait, fishing primarily from the dock or the many shore locations made accessible by trails around the lake.

Lewynsky, V.A. 1986. Creel Survey Designs for the Skagit River and Ross Reservoir Sport Fisheries. B.C. Regional Fisheries Report No. LM-107. 37 p.

The Skagit River creel survey is designed to estimate fishery parameters for the area of the Skagit River between Provincial Highway 3 and Ross Reservoir, the Sumallo River along Highway 3 and the Kesilkwa River along the Silver-Skagit Road for the period June 14 to October 31, 1986. The Ross Reservoir survey will estimate basic fishery parameters for the entire reservoir (including the Canadian portion) between June 14 and October 31, 1986.

Clark, B.J. 1985. Salmonid Fry Densities of Silverdale Creek. B.C. Regional Fisheries Report No. LM-109.

This report discusses the salmonid populations of Silverdale Creek, their densities and relationships.

Silverdale Creek was chosen as a study stream because it has been a major source of cutthroat brood stock and the focus of a number of enhancement proposals, mainly for salmon.

Clark (1980) recommended removal of the barriers upstream of Reach 4 and improvement of parr habitat for cutthroat in Reaches 2 and 3 as enhancement options. It was felt at the time that stocking cutthroat was "not viable without increased rearing areas." Since 1980 numerous groups ranging from the District of Mission to individuals have shown interest in enhancing Silverdale with salmonids but no instream work has actually taken place.

Fraser Valley Trout Hatchery (FVTH) has been taking cutthroat brood stock from Silverdale since the 1981/82 season and have been compensating the

system by returning ca 50-75 lgm fry per female taken. In the last two years FVTH has noticed a sharp decline in available adults (Appendix 1) and they do not plan to take adult cutthroat from Silverdale in the 85/86 season (Dale Larson pers. comm[1]).

Clark, B.J. 1985. Potential Stocking Areas for Steelhead Fry Within the Lower Squamish Watershed. B.C. Regional Fisheries Report No. LM-110.

This report summarizes the steelhead fry stocking potential of:

(1) the minor tributaries of the lower Squamish River (downstream of the Cheakamus River);

(2) the headwaters of the Mamquam River and its tributaries;

(3) the Little Stawamus River.

The results will enable management to determine areas within the Squamish system that would benefit most from steelhead fry produced at Tenderfoot Hatchery. At present Tenderfoots production capability exceeds the fry requirements of the Cheakamus River due to large adult escapements. (A subjective opinion based on adult returns in 1984 and 1985). This report is concerned primarily with present wild fry densities and the potential for stocking outside of the Cheakamus watershed. More detailed data of habitat descriptions, depth/velocity transects and photographs are provided in the appendices.

There is very limited potential for steelhead fry stocking in the tributaries of the lower Squamish River. This is due to high wild fry densities resulting from high adult escapement and lack of available habitat. The high adult escapement is itself a result of the catch and release regulation for steelhead within the Squamish system. Assuming this regulation is maintained, there is no need for stock augmentation in the forseeable future.

The Little Stawamus has no potential for steelhead fry stocking which would negatively impact its sea-run cutthroat population.

The headwaters of the Mamquam River and one tributary, Mashiter Creek could potentially rear between 50-87,000 fry based on the assessment in 1985 and the Mamquam River Aquatic Inventory (Pendray & McInnis, 1978).

Clark, B.J. 1985. Salmonid Populations of Wilson Creek. B.C. Regional Fisheries Project Report No. LM-111.

The anadromous cutthroat population of Wilson Creek is operating at 50 percent of the theoretical maximum capacity. An additional 4,000 fry are rquired fro optimal densities capable of producing an adult cutthroat population of 188 fish.

The stocking of coho fry at high densities in Wilson Creek does not appear to be a viable enhancement technique and may be impacting on wild salmonid populations. There is an urgent need for discussion between provincial and federal fisheries agencies to formulate a salmonid enhancement plan for the Sechelt Peninsula.

Clark, B.J. 1985. Salmonid Fry Densities of Chehalis River and Their Enhancement Potential. B.C. Regional Fisheries Report No. LM-112

Juvenile salmonid densities and their use of available habitat in the Chehalis River mainstem are discussed in this report. Emphasis is placed on steelhead fry densities and their associated micro-habitats.

Work done by the fisheries section in 1979 (Valensky, 1979) suggested that the Chehalis River was underutilized by steelhead juveniles as a result of low adult escapements. Clark (1983) proposed that physical/hydrological factors, not escapement limit the steelhead populations.

Since 1984 the Chehalis River has been stocked with adipose clipped steelhead smolts (Appendix 1). Although some jacks returned in 1985 the first return of adult hatchery steelhead is expected in 1986. This increased escapement should help to determine the 'bottleneck' limiting wild steelhead production in the Chehalis. If for example, habitat is underutilized, the augmented run should result in increased juvenile densities assuming enough hatchery adults return and utilize the available habitat. However, if the habitat/hydrology is the limiting factor then no subsequent increase can be expected past an initial fry increase.

Comparison of the 1985 fish density/micro-habitat relationships with similar relationships in the future through co-variant analysis may tell us if the juvenile steelhead populations are changing or stable.

Steelhead production in the Chehalis River is controlled by flow regime and channel form which limit overwinter survival of fry. Enhancement through stocking will not result in greater numbers of wild adults.

Whyte, I.W. 1986. Substrate Monitoring Study Davis Lake Outlet Stream. July 1985 to March, 1986. B.C. Regional Fisheries Project Report No. LM-113. 6 p.

During August and September of 1985 ECL ENVIROWEST CONSULTANTS LIMITED conducted a stream clearing project in the outlet of Davis Lake, north of Mission, B.C. In conjunction with that project a monitoring program was established to assess the impact of the clearing work on the stream's substrates.

Samples were collected at four sites between the lake outlet and the beaver dam below the lowest of three log jam sites. Samples were collected on six occasions between the summer of 1985 and the spring of 1986.

The results indicated that the removal of the log jams allowed the stream to flush itself of fine substrates which were overlying coarser materials. These coarser materials became exposed and as a result the amount of spawning gravel for cutthroat trout has been increased. The study also found that the only source of new gravels for the outlet stream is Murdo Creek, a tributary which enters the outlet near the lake.

Scott, K.J. 1986. A Data Report on Rainbow Trout Tagging and Test Fishing Studies in the Canadian Skagit River, 1986. B.C. Regional Fisheries Project Report No. LM-114. 68 p.

Scott Resource Services was retained by the British Columbia Ministry of Environment and Parks to conduct rainbow trout tagging and test fishing studies in the Canadian Skagit River between April 15 and October 31, 1986.

From April 15 to May 19, 1986, 1276 rainbow trout were captured and tagged in the lower reaches of the Canadian Skagit River. Between June 09 and October 25, 1986, 1034 rainbow trout were caught in the test fishery in the Skagit River. Seventeen (17) of these fish had red tags from the current study (1986) and one had a yellow tag from 1985. In addition, there were 128 recaptures of fish previously caught and caudal clipped in the test fishery.

Considerable biological and physical data were collected during both programs.

Scott, K.J. & V.A. Lewynsky. 1987. Creel Survey of the Canadian Skagit River, 1986. B.C. Regional Fisheries Project Report No. LM-115

An on-site creel survey of the Canadian Skagit River sport fisheries was conducted during the summer and fall of 1986, to estimate angler effort, catch by species and catch rates. From June 14, to October 31, total

angler effort was estimated at 13,157 hours (3,575 days). Estimated effort at the lower Skagit, upper Skagit and Sumallo Rivers was 9,194, 3,048 and 915 hours respectively.

During the survey period, an estimated 5,722 rainbow trout were caught, of which 4,709 (82%) were released. The estimated catch of rainbow trout at the lower Skagit, upper Skagit and Sumallo Rivers was 4,348, 1,156 and 218 fish, respectively. The estimated catch of Dolly Varden was 176 fish. Three brook trout and no cutthroat trout were caught during the fishery.

Considerable information on angler attributes is also presented.

Paish, H. 1987. Angler Survey Allouette Lake - 1986. B.C. Regional Fisheries Project Report No. LM-116. 19 p.

An estimated 1,013 angler days were fished on Alouette Lake from July 1, October 31, 1986, catching an estimated 142 game fish; including 85 rainbow trout, 10 cutthroat trout, 1 Dolly Varden char, 1 lake (trout) char, and 45 kokanee.

Most of the fishing took place in July and August, and mainly during the mid-day hours for all months. Mean angler hours per day ranged from 3 in September to 4.3 in July and August, with an average of 1.9 anglers per angling boat over the season.

Most anglers fished with no species target, but those who did were mostly fishing for rainbow trout.

Most fish caught were killed, with a slightly higher percentage of rainbow released than kokanee. Total catch success was 0.14 fish per angler day.

Only 7% of anglers were successful; almost all with only 1 fish.

Lure-bait combination was the most successful, followed by lure only and bait only.

Although over half the fishing took place in the south end of the lake, less than half the fish were taken there. The greatest success rate for rainbow trout was in the north end, while nearly half the kokanee were taken in the mid-lake section.

Only expert and intermediate-rated anglers were successful;; with "experts" out-fishing "intermediates" 3 to 1.

Fishing was the main reason for visits to the lake, and most anglers interviewed fished Alouette Lake because of its proximity to home. Almost all rated the fishery as fair or poor, and suggested that "more fish" would bring them back more often.

Reported fishing patterns suggest that the July to October survey may have included half of the total year's fishing; with the spring kokanee fishery the most significant fishery missed.

Examination of rental canoe fishing and shore fishing show that the single exit survey at the boat ramp captured almost all the successful angling done on the lake; however, several hundred angler days of enjoyment were contributed by these largely novice anglers.

Comparison of exit point survey data with Fisheries Branch aerial observations on three coincident days showed similar results for number of boats and boat anglers, but the exit survey did not estimate the number of shore anglers.

Comparison of angler boat counts withe the Fisheries Branch traffic counter on the boat ramp suggested the counter was useful only as a rough estimator of angler boat traffic.

Clark, B.J. 1985. The Enhancement of Summer Run Steelhead in Sliverhope Creek: Progress in 1985. B.C. Regional Fisheries Report No. LM-119. 18 p.

The summer run steelhead fry stocking program on Silverhope Creek has succeeded in improving the natural adult run to a level capable of seeding the available habitat at optimal densities.

It is recommended that the fry stocking program cease except for an augmentation of 40,000 fry in 1987 to strengthen a weak year class.

Poor growth rates of fry stocked into tributaries suggest that they are not capable of rearing significant numbers of fish.

Clark, B.J. 1986. The Enhancement of Summer Run Steelhead in Silverhope Creek; Progress in 1986. B.C. Regional Fisheries Report No. LM-120.

The 1986 adult steelhead escapement produced near optimal densities of 194 fry/unit in the mainstem Silverhope.

Adult runs of greater than 400 fish are projected through 1992 (306 in 1987) without any further hatchery augmentation.

Sanford, D., J.C. Abbott, and P.R. Murray. 1987. Survey of the Lower Fraser River Winter Cutthroat Fishery, November 1985-March 1986. B.C. Regional Fisheries Report No. LM-125. 34 p.

Angler effort and success was monitored in an intensive creel survey of 12 popular cutthroat trout angling locations in the Lower Fraser River area. An estimated 23,912 hours of effort was expended for an estimated catch of 1,258 cutthroat trout. Nicomen Slough was the most popular and productive site attracting 37.3% of the estimated total effort and yielding 30.3% of the estimated catch. Angler effort and catch were positively related over time and location. Marked fish of hatchery origin contributed 34.9% of the cutthroat trout catch. The majority of anglers (99.2%) were Lower Mainland residents who fished for coho salmon in November and December and cutthroat trout from January to March. Results of a less intensive survey of volunteer anglers in the De Bouville Slough-Pitt River and Chehalis River-Weaver Creek areas are reported.

Spence, C.R. and P.R. Murray. 1986. Survey of the Silverhope Creek Summer Steelhead Fisheries, 1985. B.C. Regional Fisheries Report No. LM-126. 19 p.

During June and July, 1985, a survey of angler use and summer steelhead catches on Silverhope Creek was conducted using non-uniform probability sampling. The restricted nature of the fishery allowed angler effort to be measured directly as well as through instantaneous counts. Direct measurements indicated an estimated expenditure of 1676+/-323 angler hours and catch of 147+/-71 steelhead during the two months in which the fishery was open. Estimates obtained from instantaneous count data were substantially higher. Hatchery steelhead, primarily strays from the Coquihalla River, accounted for 50% of the steelhead catch. Snorkel surveys of the upper reaches of Silverhope Creek revealed substantially more steelhead than angling success would have predicted.

Abbott, S.C., D. Sanford, and P.R. Murray. 1987. Angling Survey of the Steelhead and Cutthroat Trout Fishery in the Little Campbell, Nicomekl, and Serpentine Rivers, Winter 1985/1986. B.C. Regional Fisheries Report No. LM-127. 33 p.

Angler effort and success were monitored in the Little Campbell, Nicomekl and Serpentine Rivers from November 1985 to March 1986. An estimated 27,600 angler hours was expended on all three rivers for an estimated catch of 983 cutthroat trout and 920 steelhead. The Little Campbell River was the most popular and productive of the study rivers attracting 63% of the estimated total effort and yielding 46% and 78% of the estimated cutthroat trout and steelhead catches, respectively. The Nicomekl River attracted 27% of the

estimated effort and produced 13% and 22% of the estimated cutthroat trout and steelhead catches, respectively. The Serpentine River received little angler attention (8.9% of the estimated total effort). As a result, the reliability of the catch estimate for that river was poor. Marked fish of hatchery origin contributed 56.7% of the cutthroat trout catch and 45.7% of the steelhead catch. The majority of anglers (99.4%) were Lower Mainland residents who fished for coho salmon in November and December and steelhead in January through March.

Spence, C.R. and P.R. Murray. 1987. Survey of the Late Summer Cutthroat Trout Fishery on the Little Campbell, Nicomekl, and Serpentine Rivers, 1985. B.C. Regional Fisheries Report No. LM-128. 21 p.

The Little Campbell, Nicomekl and Serpentine River late summer cutthroat fisheries were surveyed during September, 1985 to determine angling pressure, catches and returns from recent stocking programs. Estimates of total angling effort on these streams were 12376 $\pm$ 2638, 5169 $\pm$ 1738, and 1272 $\pm$ 1052 hours, respectively. Estimated catches of cutthroat totalled 387 $\pm$ 387 on the Little Campbell, 258 $\pm$ 543 on the Nicomekl and nil on the Serpentine River. Catches comprised nearly 50% hatchery fish of which the most common were left maxillary clipped.

Spence, C.R. and P.R. Murray. 1986. Survey of the Vedder River Outlet Late Summer Cutthroat Fishery, 1985. B.C. Regional Fisheries Report No. LM-129. 19 p.

The late summer cutthroat fishery at the Vedder River outlet was surveyed using non-uniform probability sampling to determine angling pressure and catches and returns from recent stocking programs. The relative reliability of estimates derived through instantaneous counts and direct measurements of effort was also examined. Direct measurements produced angling effort and catch estimates of 5464 $\pm$ 528 hours and 804 $\pm$ 121 cutthroat, respectively, for the period August 15 - September 15, 1985. Estimates generated through instantaneous counts were at least 10% higher and had substantially reduced precision from those obtained from direct measurement data. The catch consisted of 20.3% hatchery fish.

Envirocon Limited. 1985. Fraser River - Mud Bay Angling Survey. Progress: August - October, 1985. B.C. Regional Fisheries Report No. LM-130.

The following report describes preliminary findings from cutthroat angler surveys undertaken at the Vedder River mouth (August 18 - September 15, 1985) and the Mud Bay area (September 1 - 30, 1985). A discussion of the methods and problems associated with data gathering and analysis is presented along with estimates of angler use and catches.

Clark, B.J. 1987. Preliminary Assessment of Juvenile Steelhead Densities in the Birkenhead River. B.C. Regional Fisheries Report No. LM-131.

The Birkenhead River has extremely low steelhead fry densities within excellent habitat based on depth and velocity parameters.

These densities may be due to low nutrient levels and temperature, the lack of an historical steelhead run or reduced escapements.

Eight thousand (8,000) steelhead fry were released in the fall of 1986 and will be sampled in 1987 to determine growth rates and survival.

Hickey, D.G. and I.W. Whyte. 1987. 1987 Canadian Skagit River Rainbow Trout Sampling program. B.C. Regional Fisheries Report No. LM-135.

A rainbow trout sampling program was conducted on the Canadian portion of the Skagit River between July 11 and 27, 1987. The program collected length data and scale samples from a total of 204 rainbow trout, 101 from the upper reach (Reach 2) and 103 from the lower reach (Reach 1), respectively, by means of fly-casting. The rainbow trout sampled in Reach 1 ranged in size from 150 to 383 mm, with an average fork length of 269 mm. Fish lengths ranged from 213 to 413 mm in Reach 2 with a mean fork length of 324 mm.

Clark, B.J. 1988. The Status of Cutthroat Trout in Nathan Creek (1986). B.C. Regional Fisheries Report No. LM-138.

Nathan Creek supports high densities of cutthroat trout and coho salmon fry. Its habitat and fish use has not changed significantly since 1979. Further study is required to estimate total populations and optimal densities before Nathan can be used as an accurate indicator of the status of south-side tributaries to the lower Fraser. Present habitat should be protected at all costs despite increasing land development.

Swiatkiewicz, V.J. 1984. Lower Mainland Region Fisheries Management Statement (1984). B.C. Regional Fisheries Report No. LM-140. 94 p.

The purpose of this regional planning statement is to provide long-term direction for fisheries management in the Lower Mainland Region. This is accomplished through analysis of fish production, fishery exploitation

and management strategies over the next 10 to 20 years. Because it is forward looking, this regional planning statement provides guidelines for management but is not a blueprint. It is intended to provide a relatively coarse level of data analysis and a broad management perspective. The statement has been prepared using existing data within a tight time schedule. An explicit decision was made to produce a sound regional analysis quickly rather than a flawless document slowly.

Educated guesses were applied where data were missing and opinion was substituted for fact in the absence of facts. However, the guesses and opinions were obtained from experienced managers and biologists and will gradually be replaced by better information as it becomes available. For these reasons, this regional statement should be interpreted with care and constructive criticism is invited. Simply stated, the supply and demand numbers represented are not "cut in stone."

The value of this document will be in its use by fisheries managers at the provincial and regional levels. The statement should permit the translation of provincial program goals and objectives into regionally meaningful plans with identifiable targets, strategies, timetables and resource requirements. At the same time, the regional statement will allow the preparation of sub-regional and operational plans to move ahead more quickly and will permit more orderly development and management of the regional fisheries resource. The regional statement will be updated periodically with the completion of more sub-regional plans.

Usher, J.B. 1987. Methods Report - Skagit Scale Samples 1986. Regional Fisheries Report NO. LM-141, 14 p.

This report describes the preparation of Skagit River rainbow trout scale samples for analysis and gives criteria for determining age. Measurement data (mm to each annulus) and age data will be computerized and an analysis will be made to determine composition of the stock based on the assumption that fast growth is lake growth.

Clark, B.J. 1988. The Enhancement of Summer Run Steelhead in Silverhope Creek: Progress in 1987. Regional Fisheries Report No. LM149

The summer run steelhead fry populations of Silverhope Creek have remained at optimal densities since 1984 and are capable of supporting adult returns of 400 fish without hatchery augmentation. Any change in channel form or harvest rates could effect the equilibrium.

Ninety (90) percent of fry density variation between sample sites can be explained by the depth and velocity of the channel. Steelhead parr densities are effected by depth and velocity as well as boulder cover (D90) and the sand component.

Future studies would be repetitive and it is recommended the annual assessment of Silverhope juveniles be discontinued.

Fee, J. 1988. A Survey of Lower Mainland Small Water Bodies Suitable for the Development of an Urban Fishery. B.C. Ministry of Environment, Fish and Wildlife Unit, Surrey, B.C. Regional Fisheries Report No. LM151.

93 water bodies in the lower Fraser Valley were identified for potential urban fisheries. 13 of these candidate water bodies were suited for trout stocking and 4 were suited for the development of a warm water fishery. Proposed trout stocking levels and strategies are given. Water bodies are ranked in order of suitability for trout stocking. Recommendations are made for the assessment of small urban fisheries.

Thorp, G.N. 1985. Hill Creek Spawning Channel Adult Kokanee Enumeration. B.C. Regional Fisheries Project Report No. KO-01. 13 p.

Adult kokanee returning to Hill Creek to spawn in the fall of 1985 were enumerated at a fence site located downstream of the Hill Creek spawning channel. A total of 56,576 kokanee were enumerated at this site. A further 3,600 kokanee were visually estimated below this site yielding a total return to the Hill Creek system in 1985 of 60,176 fish.

An estimated 13.4 million eggs were deposited into the Hill Creek system.

Comparisons are made with the 1984 adult return and subsequent egg deposition.

Hutchinson, J. 1984. Meadow Creek Spawning Channel Adult Kokanee Enumeration and Subsequent Fry Production. B.C. Regional Fisheries Project Report No. KO-02. 33 p.

Kokanee escapement in the Meadow Creek system for 1984 was close to 0.5 million. The combination of egg deposition in the channel, above and below, was calculated to be nearly 40 million eggs. These totals clearly present an increase over 1983 by 183,000 spawners and 7 million eggs. Spawner size and fecundity were the lowest recorded to date.

Major channel renovation work occurred in 1983 and 1984 with new gravel placed in the channel for the 1984 spawning run. Success of this renovation work was determined by fry enumeration in the spring, 1985.

Estimated fry production from the Meadow Creek system was in excess of 7.7 million fry in 1985. It was determined that the survival rate of above the channel was 8% and nearly 40% within the spawning channel.

Continued assessment of the channel in this way will confirm Meadow Creek production capabilities.

Thorp, G.N. 1985. Hill Creek Rainbow Brood Stock Collection and Subsequent Yearling Production. B.C. Regional Fisheries Project Report No. KO-03. 9 p.

The 1985 rainbow trout brood collection at the Hill Creek spawning channel and subsequent yearling production in the Hill Creek hatchery are summarized. Comparisons are made with the 1984 brood collection and subsequent yearling production.

Thorp, G.N. 1985. Hill Creek Spawning Channel Kokanee Fry Enumeration. B.C. Regional Fisheries Project Report No. KO-04. 9 p.

In the spring of 1985, kokanee fry production was estimated from the Hill Creek spawning channel. This was the first year fry enumeration was conducted from kokanee which spawned naturally in the channel. A total of three (3) million fry were produced resulting in an egg to fry survival of 69.2%.

Fleck, J.L. 1985. Redfish Creek Spawning Channel Kokanee Enumeration 1984 and Fry Production 1985. B.C. Regional Fisheries Project Report No. KO-05. 17 p.

Redfish Creek is a small but important tributary stream to the West Arm of Kootenay Lake. In 1981-82 an artificial spawning channel was constructed adjacent to Redfish Creek. During the autumn of 1984 a total of 2440 kokanee spawned in the channel depositing 1,190,772 eggs in the gravel.

In the spring of 1985, a relative measure of kokanee fry production was estimated from the spawning channel. A total of 0.15 million fry were produced resulting in an egg-to-fry survival of 12.6%.

Thorp, Grant N. 1986. Hill Creek Rainbow Brood Stock Collection and Subsequent Yearling Production. Unpublished M.S., Fisheries Branch, Nelson, B.C., No. KO-6, 8 p.

In spring 1986 rainbow trout returning to the Halfway River, MacKenzie Creek and the Hill Creek spawning channel were captured for egg collections. A total of 47 adults were collected of which 44 were native Hill Creek stock and three "trophy" stock released into Hill Creek in 1981 and 1982. Just over 28,000 eggs were collected from the Hill Creek stock.

Eggs were incubated in the Hill Creek Hatchery and subsequent yearling production was 23,000, resulting in a 80% egg-to-yearling survival rate.

Based on an estimated return rate of 2% from yearling to adult (including catch in the creel) approximately 460 adults should return to spawn in 1991 when the fish are 5 years old.

Gates, R. 1986 Gerrard Rainbow Trout Spawning Population and Egg Collection 1986. Unpublished M.S., B.C. Fisheries Branch, Nelson, B.C., Report No KO-7.

In the spring of 1986 the spawning population of Gerrard rainbow trout were enumerated and some eggs were collected for incubation and rearing at Meadow Creek hatchery.

A peak count of 378 fish spawned at Gerrard and a total of 16,300 eggs were collected.

Lindsay, R.A. 1985-1986. Upper Arrow Reservoir Sport Fishery Statistics. Unpublished M.S., Fisheries Branch, Nelson, B.C., Report No. KO-8, 26 p.

Catch and effort data on the Upper Arrow reservoir derived from a year-round creel census are analyzed. Fisheries trends for rainbow trout, Dolly Varden and kokanee are analyzed and compared form 1976-1986.

Fish restoration programs relative to construction of the Revelstoke 1880 Dam and their effects on the sport fishery are outlined.

Fleck, J.L. 1985-1986. Redfish Creek Spawning Channel Kokanee Enumeration 1985 and Fry Production 1986. Unpublished M.S., Fisheries Branch, Nelson, B.C., Report No. KO-9. 15 p.

Redfish Creek is a small but important tributary stream to the West Arm of Kootenay Lake. In 1981-82 an artificial spawning channel was constructed adjacent to Redfish Creek. During the autumn of 1985 a total of 5,013 kokanee returned to the spawning channel. From this total 231 fish were moved to Mill Creek and 819 fish to Kokanee Creek spawning channel leaving some 3,963 fish to spawn in the channel depositing 1,519,054 eggs in the gravel.

In the spring of 1986, kokanee fry production was estimated from the spawning channel. A total of 0.42 million fry were produced resulting in an egg-to-fry survival of 30.4%.

Thorp, G.N. 1986. Hill Creek Spawning Channel Kokanee Fry Enumeration Spring 1986. Unpublished M.S., Fisheries Branch, Nelson, B.C. Report No. KO-10. 10 p.

In fall 1985, approximately 40,200 kokanee spawned in the Hill Creek channel (Thorp, 1985) resulting in an egg deposition of 9 million. Resultant fry outmigration was 4.2 million which represents a 47.6% egg-to-fry survival rate. Based on previous fry-to-adult survival rates in Hill Creek of about 5% (Thorp, 1985), the expected adult return in 1989 from channel production is 210,000.

The expected total adult return in 1989 from natural stream production, a fed fry release and spawning channel production is 225,650.

Lindsay, R.A. 1986. Culture and Release of Rainbow Trout Reared in Net Pens at the Lower Arrow Reservoir and Slocan Lake. Unpublished M.S., Fisheries Branch, Nelson, B.C. Report No. KO-11. 5 p.

Documentation of culturing of rainbow trout in net pens in a freshwater lake environment was recorded. Overwinter growth was monitored from fingerling to yearling release resulting in the Slocan Lake pen producing fish with a mean length and weight of 12 cm and 20 grams, respectively. In the Lower Arrow pen mean length and weight of fish was 14 cm and 32 grams, respectively. Overall size appeared to be dependent on rearing density.

Hutchinson, J. 1985. Incubation and Rearing of Gerrard Rainbow Trout at Meadow Creek 1985 Year Class, Unpublished M.S., Fisheries Branch, Nelson, B.C. Report No. KO-12. 17 p.

This paper includes the results of incubation, rearing and release of the 1985 Gerrard Rainbow trout from the meadow Creek hatchery. These results are compared with previous years by number, survival rates, mortalities, growth rates and overall production.

In 1985 twenty-five thousand seventy-six (25,076)* eggs were collected at Gerrard. Over half those eggs developed into fry, but with high mortality during the early fry stage just over 50% survived to yearling size.

Following fin clipping by a contractor, the fish were released in June at a mean weight of 10.1 grams. Total Gerrard production released from Meadow Creek in 1986 was 7,583.

*eggs from unmarked or wild females

Fleck, J.C. 1985-1986. Kokanee Creek Spawning Channel Kokanee Enumeration 1985 and Fry Production 1986. Unpublished M.S., Fisheries Branch, Nelson, B.C. Report NO. KO-13. 11 p.

Kokanee Creek is the large of the tributary streams to the West Arm of Kootenay Lake. In 1984-85 an artificial spawning channel was constructed.

During the autumn of 1985 a total of 2658 kokanee spawned in the channel depositing 1,023,620 eggs in the gravel. In the spring of 1986, kokanee fry production was estimated from the spawning channel. A total of 0.32 million fry were produced resulting in an egg to fry survival rate of 30.8%.

Martin, A.D. 1987. Creel Survey Results from a High Elevation Lake Situated in Southeastern British Columbia for 1986. Kootenay Region Fisheries Technical Circular No. KO-14. 11 p.

Creel surveys were conducted on Fish Lake from June 1 to September 17, 1986. An estimated 739 anglers spent 1,375 rod hours to catch 1,840 fish. The lake contains wild populations of cutthroat trout and Dolly Varden char (bull trout). Cutthroat comprised 91% of the harvest. Annual effort and harvest were 116 rod hours and 20 kg per hectare, respectively. Restrictive regulations are required on the system to maintain the fishery in the face of increasing angler effort.

Oliver, G.G. 1987. Artificial Circulation of a Small Mesotrophic Lake in Southeastern British Columbia. Ministry of Environment and parks, Fisheries Branch, Kootenay Region. Fisheries Project No. KO-16. 22 p.

Artificial circulation of a small lake in southeastern British Columbia during the winters of 1985 and 1986 prevented winterkill. The objective was to ensure overwinter survival of rainbow trout to create a sports fishery.

Artificial circulation increased the areal depletion rate. Mean oxygen concentrations of 1.8 mg/l or greater were maintained both winters. Artificial circulation reduced the water temperature of the lake to 1-2° C. Oxygen levels were sufficient to sustain the throat population.

The creation of a popular lake fishery has provided an additional angling opportunity in the East Kootenay. Approximately 2100 angler days were estimated in 1985. Future use is projected between 3-5000 angler days.

Hutchinson, J. 1987. Meadow Creek Spawning Channel Adult Kokanee Enumeration and Subsequent Fry Production Report 1986. Unpublished M.S., Fisheries Branch Nelson, B. C. Report No. KO-17.

Actual enumeration and visual estimates of kokanee adults in the fall of 1985 at Meadow Creek amounted to almost one million fish. This result is greater in all sections of the system than reported last year. In fact, a return of this magnitude has not been observed since 1981 and prior to the 1975-1978.

The subsequent egg collection was equally successful. In excess of three million eggs were obtained for incubation. Some 89 million eggs were deposited naturally throughout the Meadow Creek system.

To complete evaluation of Meadow Creek production an estimated 2.7 million fry were enumerated in the spring of 1986. This means the egg-to-fry survival rate was only 9.8%. The drop in production is largely due to a destructive flood midway through the fry emigration period which cut in-channel flows and deposited unusual amounts of silt in the channel.

Martin, A.D. 1987. Rainbow Trout Fry Production from the Whiteswan Lake Spawning Channel in 1986 B.C. Ministry of Environment and Parks, Fisheries Branch, Kootenay Region. Fisheries Project No. 18, 21 p.

Whiteswan Lake Spawning Channel supported 874 spawning rainbow trout in 1986. Spawners entered the channel from May 16 through to June 14 with the majority of fish spawning in the first two weeks of June. The sex ratio of trout in the channel was 1.0° to 0.99°. The average fecundity of female trout (mean fork length 42.05 cm) was 1,007 eggs. Egg retention following spawning was low. The potential deposition in the spawning channel was estimated at 420,000 eggs. Few (1,377) fry were enumerated indicating very poor survival. The production of fry from eggs deposited in mid May to the fry stage indicated water quality in the channel was initially suitable for incubation and emergence, however, high water temperatures of 16 to 18° C in late May and June resulted in poor survival of the majority of eggs deposited.

Increased fry production is dependent on reducing water temperatures. The channel is subjected to high water temperatures due to its location below the outlet of Alces Lake. Construction of a deep level outlet to draw cool hypolimnetic water from the lake would reduce water temperatures in the channel. Drop structures should be placed at the outlet and through the channel to increase dissolved oxygen concentration. A detailed hydrological evaluation by Ward 1986 indicates that a deep level outlet would reduce water temperatures in the spawning channel by 4° C. This would reduce the water temperatures to 13-14°C suitable for the successful incubation of eggs and emergence of rainbow trout fry in the spawning channel.

Andrusak, H. 1987. Kootenay Lake Sport Fishery 1984-1986 Unpublished M.S., Fisheries Branch, Nelson, B.C. Report No. KO-19. 31 p.

Sport fish statistics gathered on Kootenay Lake from 1984-1986 are analyzed. Catch and effort are summarized for the three arms of the lake and compared with previous years information.

Fleck, J.L. 1986-1987. Kokanee Creek Spawning Channel Kokanee Enumeration 1986 and Fry Production 1987. Unpublished M.S., Fisheries Branch, Nelson, B.C. Report No. KO-26. 19 p.

Kokanee Creek is the largest of the three tributary streams to the West Arm of Kootenay Lake which support spawning kokanee. In 1984-85 an artificial spawning channel was constructed to increase kokanee production.

During the fall of 1986, adult kokanee were enumerated and in the spring of 1987 fry production was measured. A total of 4,647 kokanee spawned in the channel depositing 1,540,640 eggs in the gravel. In the following spring a total of 437,721 fry were produced resulting in an egg-to-fry survival rate of 29.0%.

Thorp, Grant N. 1987. Hill Creek Rainbow Brood stock Collection and Subsequent Yearling Production, Unpublished, M.S., Fisheries Branch, Nelson, B.C. No. KO-20. 8 p.

In spring 1987 rainbow trout returning to Hill Creek spawning channel were captured for egg collections. A total of 23 adults were collected, consisting of 22 native Hill Creek stock and one "trophy" fish.

Approximately 8,655 eggs were collected from the Hill Creek stock. Eggs were incubated in the Hill Creek Hatchery and subsequent yearling production was 5,100, resulting in a 59% egg-to-yearling survival rate.

Based on an estimated return rate of 2% from yearling to adult (including sport catch) 102 adults should return to spawn in 1992 when the fish are 5 years old.

Thorp, Grant N. 1986. Hill Creek Spawning Channel Adult Kokanee Enumeration Fall 1986. Unpublished M.S., Fisheries Branch, Nelson, B.C. Report No. KO-21 19 p.

Adult kokanee returning to Hill Creek to spawn in the fall 1986 were enumerated at a fence site located downstream of the Hill Creek spawning

channel. A total of 71,889 kokanee were enumerated at this site of which 35,199 entered the Hill Creek spawning channel. A further 4,000 kokanee were visually estimated below this site yielding a total return to the Hill Creek system in 1986 of 75,889 fish.

An estimated 12.7 million eggs were deposited into the Hill Creek system. Production from the 1986 spawning effort is expected to yield an adult return of 191,000 in 1990.

Thorp, G.N. 1987. Hill Creek Spawning Channel Kokanee fry Enumeration Spring 1987. Unpublished M.S., Fisheries Branch, Nelson, B.C. Report No. KO-22. 18 p.

In fall 1986, approximately 75,889 kokanee entered Hill Creek of which 35,200 kokanee spawned in the Hill Creek spawning channel resulting in an egg deposition (in the channel) of 5.88 million (Thorp, 1986. M.S.). Subsequent fry production in spring 1987 was estimated to be 3.97 million which represents a 67.5 egg-to-fry survival rate.

The projected adult return in 1990 from natural stream and spawning channel production is 215,635.

Thorp, Grant N. 1987. Hill Creek Spawning Channel Adult Kokanee Enumeration 1987. Unpublished M.S., Fisheries Branch, Nelson, B.C. Report No. KO-23. 18 p.

Adult kokanee returning to Hill creek to spawn in the fall 1987 were enumerated at a fence site located downstream of the Hill Creek spawning channel. A total of 103,528 kokanee were enumerated at this site of which 73,437 entered the spawning channel. A further 4,000 kokanee were visually estimated below this site yielding a total return to the Hill Creek system in 1987 of 107,528 fish.

An estimated 14.5 million eggs were deposited into the Hill Creek system (natural creek plus spawning channel). Production from the 1987 spawning effort is expected to yield an adult return of 309,000 in 1991.

Lindsay, R.A. 1987. Lower Arrow Reservoir Sport Fishery Statistics. Unpublished M.S., Fisheries Branch, Nelson, B.C. , Report No. KO-24. 14 p.

Effort and catch data on the Lower Arrow reservoir derived from creel census data are analyzed. Fisheries trends for rainbow trout, Dolly Varden and kokanee are analyzed and compared from 1967 to 1987.

Gates, R. 1987. Gerrard Rainbow Trout Spawning Population and Egg Collecton Data 1987. Unpublished M.S., B.C. Fisheries Branch, Nelson, B.C., Report No. KO-25. 11 p.

In the spring of 1987 the spawning population of Gerrard rainbow trout was enumerated and monitored. A few fish were trapped and eggs were collected for incubation and rearing at the Meadow Creek hatchery.

A peak count of 294 fish was recorded and a total of 60,000 eggs were collected.

FISHERIES PROJECT REPORTS - CARIBOO REGION

Westover, W.T. and George, G.A. Sheridan Lake Sports Fishery: History, Enhancement and Results of a 1986 Creel Census. 1987. Fisheries Project Report No. CA-1, 20 p.

A brief history of the Sheridan Lake sports fishery is discussed including results of a creel census conducted between May and October 1986. Effort during this time period was estimated to be 29,147 angler days resulting in a catch of 12,026 rainbow and 1,265 brook trout. An estimated 15% of the rainbow trout yearling equivalents stocked are subsequently caught in the fishery. Present angling effort on Sheridan Lake represents an economic value to the Province of approximately one million dollars per annum.

Enhancement projects to reduce numbers of egg bound fish in Sheridan Lake are also discussed.

Westover, W.T. 1987. Habitat Conservation Fund: An Evaluation of the Puntzi Lake Rainbow Trout Fishery and Fry Stocking Program. Fisheries Project Report No. CA-2, 26 P.

The Puntzi Lake rainbow trout fishery is described in terms of spawner escapement, angler catch, natural recruitment and fry stocking.

Average catch per angler day for rainbow trout at Puntzi Lake has declined from 5.6 in 1964 to 0.3 in 1986. This drop in angling success is the result of increased beaver activity, low flows, reduced spawner access and poaching of rainbow spawners from Puntzi Creek (the only spawning stream).

Of the 48,714 marked hatchery rainbow liberated into Puntzi Lake in 1983, 249 (0.5%) can be accounted for to date; 166 angler caught in 1985, 31 angler caught in 1986, 40 shoal spawners and 12 stream spawners in 1986.

Chapman, B.C. 1988. Horn, Bluff, and Sapeye Lakes Sport Fishery: Results of a 1987 Creel Census. B.C. Regional Fisheries Project Report No. CA-03. 17 p.

Chemical and physical characteristics of the three study lakes are described as well as the results of a creel census conducted from June to October 1987.

Catch per angler day ranged from a low of 0.66 at Horn to a high of 1.35 at Bluff Lake. Eighty seven percent of the catch were rainbow trout while the remaining 13% were Dolly Varden. Length, weight and age distribution for rainbow trout is presented for each lake.

Westover, W.T. 1988. Results of a 1987 Creel Census Program on Chimney, Dragon, Dugan and Fawn lakes. Fisheries Project Report No. CA-4, 19 p.

The sport fisheries on Chimney, Dragon, Dugan and Fawn lakes are solely dependent on stocking programs. Total angling effort and success were measured for these stocked lakes during the open water fishery in 1987. Survival to the creel for stocked fish was estimated and recommendations suggested for future liberations.

FISHERIES PROJECT REPORTS - OKANAGAN REGION

Bull, C.J. 1985. Management Plans: Warm Water Gamefish Management Plan, Region 8. B.C. Regional Fisheries Project Report No. OK-1 (Okanagan #2048). 26 p.

Bull, C.J. and C.J. Houston. 1985. A Method for Ranking Stocking Requests. B.C. Regional Fisheries Project Report No. OK-2 (Okanagan #2066). 21 p.

Houston, C.J. 1985. Creel Census: Aerial Boat Count Data to 1984. B.C. Regional Fisheries Project Report No. OK-3 (Okanagan #2202). 71 p.

Houston, C.J. 1985. Creel Census: Scale Reading Data. B.C. Regional Fisheries Project Report No. OK-4 (Okanagan #2203). 137 p.

Houston, C.J. 1985. Creel Census: Regional Creel Census Data. B.C. Regional Fisheries Project Report No. OK-5 (Okanagan #2204). 29 p.

Houston, C.J. 1985. Fish Culture: Skaha Hatchery Operation Manual Technical Report. B.C. Regional Fisheries Project Report No. OK-6 (Okanagan #2210). 21 p.

Harper, W.L. 1985. Kokanee Management Plan for the Okanagan Main Valley Lakes. B.C. Regional Fisheries Project Report No. OK-7 (Okanagan #2214). 64 p.

Clemmons, E. 1985. Freshwater Trout Farming in British Columbia. B. C. Regional Fisheries Project Report No. OK-8 (Okanagan #2392). 24 p.

Jantz, B. 1986. Inventory: Creel Survey and Life History Characteristics of Rainbow Trout and Kokanee in Mabel Lake, 1984. B.C. Regional Fisheries Project Report No. OK-9 (Okanagan #2404). 35 p.

Field, P.W. 1985. Trout Creek Spawning Channel Feasibility Study. B.C. Regional Fisheries Project Report No. OK-10 (Okanagan #2421). 41 p.

Bull, C.J. 1986. Fish Culture: Provincial Hatchery Production and Allocation - Report of the Hatchery Allocation Committee. B.C. Regional Fisheries Project Report No. OK-11 (Okanagan #2446). 14 p.

Ministry of Environment, Okanagan Sub-Region and Planning and Assessment Branch. 1986. Similkameen Strategic Environmental Plan Synopsis. B.C. Regional Fisheries Project Report No. OK-12 (Okanagan #2454). 116 p.

Merkley, L. 1986. Chemical Rehabilitation of Burnell Lake. B.C. Regional Fisheries Project Report No. OK-13 (Okanagan #2502). 16 p.

Houston, C.J.G. 1985. Okanagan Main Valley Lakes Creel Census 1978 - 1981. B.C. Regional Fisheries Project Report No. OK-14. 36 p.

Bull, C.J. 1987. Okanagan Lake Plan. B.C. Regional Fisheries Project Report No. OK-15. 39 p.